THE

# INTELLECTUAL OBSERVER:

REVIEW OF NATURAL HISTORY,

## MICROSCOPIC RESEARCH,

AND

## RECREATIVE SCIENCE.

VOLUME I.

ILLUSTRATED WITH PLATES IN COLOURS AND TINTS, AND NUMEROUS ENGRAVINGS ON WOOD.

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# CONTENTS.


| | PAGE |
|---|---|
| WORK OF THE YEAR. By SHIRLEY HIBBERD, F.R.H.S. | 1 |
| PRIME MOVERS. By J. W. M'GAULEY | 10 |
| ON FLUKES. By T. SPENCER COBBOLD, M.D., F.L.S. *With a Coloured Plate* | 24 |
| ROMAN CEMETERY OF URICONIUM. By THOMAS WRIGHT, M.A., F.S.A. *With Illustrations* | 33 |
| THE SKIPPER, SKOPSTER, OR SAURY. By JONATHAN COUCH, F.L.S. *With Illustrations* | 46 |
| A ROTIFER NEW TO BRITAIN (Cephalosiphon Limnias). By PHILIP HENRY GOSSE, F.R.S. *With a Tinted Plate* | 49 |
| NOTES ON THE PRECEDING PAPER. By HENRY JAMES SLACK, F.G.S. *With Illustrations* | 53 |
| ANCIENT AND MODERN FINGER-RINGS. By H. NOEL HUMPHREYS. *With Illustrations* | 57 |
| THE EARTH IN THE COMET'S TAIL. By the Rev. T. W. WEBB, F.R.A.S. *With an Illustration* | 63 |
| JOTTINGS ON COPPER (Percy's Metallurgy) | 67 |
| TRANSIT OF MERCURY ON NOV. 12, 1861. By the Hon. Mrs. WARD. *With Illustrations* | 71 |
| CONDITIONS OF INFUSORIAL LIFE | 85 |
| CUNEATIC CHARACTERS OF BABYLON, ASSYRIA, AND PERSIA. By H. NOEL HUMPHREYS. *With Illustrations* | 98 |
| INSECT VISION AND INSECT SLEEP. By the Hon. RICHARD HILL | 102 |
| APPLICATION OF THE MICROSCOPE TO THE ART OF DESIGN. By HENRY J. SLACK, F.G.S. *With a Tinted Plate* | 111 |
| COMMON LIVER ENTOZOON OF CATTLE. By T. SPENCER COBBOLD, M.D., F.L.S. *With a Coloured Plate* | 115 |
| VISIT TO THE PYTHON IN THE ZOOLOGICAL GARDENS. By SHIRLEY HIBBERD, F.R.H.S. | 123 |
| THE AYE-AYE. By W. B. TEGETMEIER. *With Illustrations* | 130 |
| IDOL HEAD OF THE JIVAROS. By WILLIAM BOLLAERT, F.R.G.S. *With an Illustration* | 135 |
| MEDIÆVAL ENGLAND | 137 |
| DOUBLE STARS. By the Rev. T. W. WEBB, F.R.A.S. *With a Diagram* | 143 |
| BEES AND THEIR COUNTERFEITS. By H. NOEL HUMPHREYS. *With a Coloured Plate and other Illustrations* | 165 |
| SHELL OF THE CUTTLE-FISH | 174 |
| ALUMINIUM. By J. W. M'GAULEY | 176 |
| HUNTING FOR DIATOMS | 190 |
| EYE OF THE COD-FISH. By T. SPENCER COBBOLD, M.D., F.L.S. *With a Coloured Plate* | 199 |
| THE VOYAGE OF AGUIRRE IN SEARCH OF EL DORADO | 209 |
| THE NEW TEMPLE OF INDUSTRY. By JOHN HOLLINGSHEAD | 212 |
| OBSERVED HEIGHTS OF METEORS AND SHOOTING STARS. By ALEXANDER S. HERSCHEL, B.A. *With a Diagram* | 217 |
| THE FISH WORLD AT HOME | 223 |

PAGE

Planets of the Month. By the Rev. T. W. Webb, F.R.A.S. ..... 230
The Genus Cephalosiphon. By Andrew Pritchard ..... 234
Progress of Zoology. By Shirley Hibberd. *With Illustrations*..... 245
Work for the Telescope—Planets of the Month—Double Stars. By the Rev. T. W. Webb, F.R.A.S. .....265, 373
Haunts of the Condor in Peru. By William Bollaert, F.R.G.S. *With a Tinted Plate*..... 278
M. Faye on Solar Repulsion ..... 286
Hybernation of Fungi—The Genus Sclerotium. By the Rev. Miles Joseph Berkeley, M.A., F.L.S. *With Illustrations* ..... 288
Roman Mining Operations on the Borders of Wales. By Thomas Wright, M.A., F.S.A. *With a Tinted Plate and other Illustrations* ... 295
Meteorological Observations at the Kew Observatory. By C. Chambers ..... 309
Life Changes on the Globe. By Henry J. Slack, F.G.S. ..... 325
Beautiful Exotic Bees. By H. Noel Humphreys. *With a Coloured Plate* ..... 334
Art of Electro-Plating and Gilding. By Richard Bethell. *With Illustrations* ..... 339
Parasites from the Zoological Gardens. By T. Spencer Cobbold, M.D., F.L.S. *With a Coloured Plate* ..... 347
The Angler. By Jonathan Couch, F.L.S. *With an Illustration*..... 353
Principles of Spectrum Analysis. By Thomas Rowney ..... 362
Feathered Reptile of Solenhofen ..... 367
Secchi on Magnetic and Atmospheric Perturbations ..... 368
Geological Value of Recent Occurrences. By George E. Roberts. 370
Exhibition Tactics..... 375
Acari in Photographic Baths and Chemical Solutions ..... 378
The Great Foucault Telescope ..... 380
Dialysis. By W. B. Tegetmeier ..... 381
Gamgee on Unwholesome Food..... 385
Ways of the Orchids ..... 387
The Hairless Men of Australia ..... 393
Money and Moneyers. By Joseph Newton. *With Two Illustrations in Silver*..... 405
Machinery at the Exhibition. By J. W. M'Gaulay ..... 421
Hail and Snow. By Alexander S. Herschel, B.A. ..... 428
Saturn's Ring—Double Stars—Occultations. By the Rev. T. W. Webb, F.R.A.S. ..... 431
Hurricane of May, 1862. By E. J. Lowe, F.R.A.S. *With Illustrations.* 439
Entomostraca (Water-Fleas). By G. S. Brady, M.R.C.S. *With Illustrations* ..... 446
Frontal Sinuses of Bos Buffalus. By Shirley Hibberd, F.R.H.S. *With an Illustration* ..... 457
Jenyns's Memoir of Henslow..... 459
Balbiani on the Reproduction of Infusoria. *With Illustrations* ... 463
Australian Naturalists ..... 469
The Domestication of Science ..... 471
Proceedings of Learned Societies .....76, 152, 235, 319, 394, 475
Gleanings from the International Exhibition ..... 398
Notes and Memoranda .....82, 160, 240, 323, 401, 481

# THE INTELLECTUAL OBSERVER.

FEBRUARY, 1862.

## THE WORK OF THE YEAR.

The progress of science during a single year must depend, in some degree, on the recurrence of special phenomena in Nature to give occasion for inquiry, experiment, and speculation. The pure sciences are in so large a measure independent of phenomena, that their progress is at any time a fair criterion of the activity of thought; but in the various departments of physics, man has to wait upon Nature, to follow where she leads him; to encounter the difficulties of untrodden paths as she may point the way, and whisper of what is to be sought there. The history of science might be used as profitably, to illustrate the relations of human character and human knowledge to external circumstances, as the history of the nation or the individual in the development of successive phases of moral phenomena. In the analysis of cosmical laws, we must shape our courses as eclipses, and occultations, and transits may occur; the changes of the seasons give the proper subjects for the inquiries of the meteorologist; and in geology an earthquake, a volcanic eruption, or a landslip, may disclose facts that appear to nullify previous conclusions, so as to demand a reconsideration of points supposed to have been settled long ago. In these matters, for all the purposes of scientific inquiry, man is the creature of circumstances. But it is no less true that in the same pursuit he creates circumstances; and in geography, zoology, botany, chemistry, and other allied sciences, he is as often the inventor of methods of exploration, comparison, and experiment, as he is, on the other hand, incited to research by the varying aspects of the phenomenal. It has become a necessity of our civilization that events should be grouped and classified from week to week, from month to month, from year to year. But it must ever be borne in mind that no single week, month, year, or even cycle of years, will exhibit accurately the whole of the attainments of that one period, nor can it furnish every datum necessary to an estimate of the magnitude, and importance, and bearing, and scope of all the labours of the

cultivators of physical science. The majority of results are like graftings upon old stocks; if every graft grows with vigour, they must be traced to the root that gives them life, ere we can determine the age and value of the tree. The latest improvement in telegraphs may be but a new graft upon the stock planted by Franklin; and in the improved chemical nomenclature on the basis of the theory of equivalents we must recur mentally to John Dalton, who believed he had attained to the ultimate atomic constitution of matter—doubly unconscious that as his first idea would in time begin to refute itself, yet in doing so it would acquire a practical value to which it is impossible to assign limits.

We must judge the year 1861 by what it has done to ripen into facts the suggestions of preceding years; we must judge it too by what it has actually added to the cumulative power of scientific thought; we must (if we can) judge it yet further by the nature of the work it has cut out for posterity. Divisions of time are altogether artificial, as compared with the activities of the human mind; and therefore, in sketching the history of science during the past year, we are, as it were, cutting out a portion from the woof of the continuous fabric which indicates only the nature of the pattern without affording any very definite hints of either its beginning or its end.

Among the astronomical events of last year, the great comet of June and July must have first place. Unlike Donati's, which emerged from the depths of space as a mere speck, and rapidly expanded into vast proportions in its speed towards the sun, this, first seen by Mr. Burden, of Clifton, acquired almost immediately its full proportions as a phenomenon in its perihelion passage, and then dwindled away as it sped into the far and mysterious regions of its aphelion. This comet played the sphynx as imperturbably as its gigantic predecessor. Unlike Donati's, which was photographed in seven seconds, it refused to impress its image on the most sensitive plates, and its elements were not correctly determined until after it had vanished from our view. Then it was we found ourselves in possession of two items of possible knowledge in regard to it: first, that it was doubtless identical with the comet of 1684; second, that the earth had passed through its tail, experiencing no other effect than the auroral glare described by Mr. Lowe and Mr. Hind, as characteristic of the atmosphere on the 30th of June. The transit of Mercury on the 13th of November, and the eclipses of the sun and moon in December, were each, of necessity, so imperfectly seen in these islands, that the records of the occurrences have no conspicuous place in the annals of science. Though we must wait till 1865 for an

eclipse which shall equal in interest that of July, 1860, there will be in the present year a sufficiency of special subjects to engage astronomers. Let it be an encouragement to amateurs to observe the aspects of the disc of the sun during March and September, that the supposed inter-Mercurial planet Vulcan was first discovered on March 26th, 1859, by Dr. Lescarbault, with means so simple that the discovery stands alone in this respect among the accomplishments of observation. There is the more encouragement, too, that M. Leverrier believes there are many planets circulating within the orbit of Mercury, so we may anticipate successive discoveries to prove the immediate region of the solar orb as thickly peopled as the interval between Mars and Jupiter. Here again is encouragement of the same kind, for of the planetoids, now seventy-one in number, the greater proportion have been discovered by amateurs. The new satellite of Saturn, and the new views obtained of the structure of the rings of that planet, will afford subjects of peculiar interest for observers during the present year.

From astronomical we turn to cosmical subjects; and prominent among the work of the past year we must place the researches of Dr. Thomson, on the age of the sun's heat, on which a paper was read before the British Association. Dr. Thomson endeavours to show that we have, in the present potential energy of the sun, a measure of its duration, past and present, and, strangely, the conclusions arrived at bear directly on the Darwinian hypothesis. Mechanical energy is indestructible, but there is ever a tendency to its dissipation, which produces gradual augmentation of heat, cessation of motion, and exhaustion of potential energy by which heat is produced. Some heat is probably produced in the sun by the influx of meteoric matter, and the amount thus generated may be sufficient to compensate the loss by radiation. Considerations derived from the disturbances of the inferior planets and the zodiacal light, show that the amount of meteoric matter cannot be enough to give a supply, at the present rate, for 300,000 years, a conclusion ratified by Leverrier by his researches on the motions of the planet Mercury. Considerations of the motions of comets prove that the meteoric matter must be derived from spaces near the sun, the cooling of which, by radiation, cannot be more than 1°·4 centigrade annually. Adding chemical considerations to those of a strictly astronomical character, he concludes that the sun cannot have illuminated the earth for 100,000,000 years, and it is certain it has not done so for 500,000,000 years. Therefore the conditions under which life has passed through its successive phases on this planet, have not been in continuance long enough to insure the results demanded by prevalent theories of organic transmutation. In

regard to Mr. Darwin, Dr. Thomson concludes that his geological estimates of time, necessary to the postulates on which he reasons, are entirely inconsistent with the chronology of the sun, to which cosmical laws induct us. No doubt, upon the basis thus hypothetically proposed, the researches now so ably carried on in photo-heliography will add many curious and important facts, and our new views of the spectrum may aid still further in revealing the chemical constitution of the luminous atmosphere as well as of the denser fabric of the solar body. The reduction of the phenomena of terrestrial magnetism to something like an order of periodicity, affords another connecting link between meteorology and the more strictly cosmical departments of physics. The tabulated observations of magnetic disturbances indicate a close relationship between these and the changes of weather on the earth's surface, both being apparently subject to cyclical revolutions, embracing periods of between ten and eleven years. There is now a stronger probability than ever that the magnetic needle will prove the true key to meteorological law, and the weather predictions of Admiral Fitzroy may be expected ere long to give place to bolder foreshadowings of atmospheric disturbance and alternations of solar heat. But while resting in these, and hesitating to draw the line between a *fait accompli* and a possibility of the future, what a daily witness has the world now of the direct value of researches and speculations in science! "Hoist drum," is the brief word by which the mariner is warned, and by obedience to which human lives and costly argosies are saved from the grasp of the approaching storm: a grand vindication of those forbidding statistics to which meteorology has been so long committed as a science of detail rather than of general principles applicable to purposes of the highest usefulness and mercy.

Chemistry is so little influenced in its progress by the changes of the seasons, and the varying aspects of the heavens, that its successive contributions to the stock of useful knowledge keep pace very closely with the march of time. Among its numerous accomplishments two distinct modes of analysis stand out conspicuously. Strictly speaking, the discovery of Bunsen and Kirchoff is not chemical, but actinic; but its applications will immediately interest and concern the chemist, who may now work conjointly with the astronomer, informing him what are the constituent elements of those planetary and solar masses, about the movements of which he is so ardently occupied. The immediate result of the application of spectrum bands to the identification of inorganic bodies, was the discovery of two new metals, *cæsium* and *rubidium;* then we were conducted by the same method to an analysis of the source of light, and the

sun was shown to be a solid or liquid photosphere, bathed in an enveloping atmosphere containing iron, sodium, potassium, lithium, and other metals, in a state of permanent sublimation. Discovery, through the aid of the prism, will not stop here. Science promises that we shall soon know why the planet Venus is so pre-eminently lustrous, like a burnished silver mirror; why Mars has upon his homely visage the hue of a subdued fire; why Saturn looks so cold, and Uranus so peculiarly metallic. The mysteries of the spectrum conduct us beyond the boundaries of the solar system, and offer means of analyzing the constitution of the stellar masses; so that Procyon and Syrius, "red Orion, and Arcturus huge," may severally be made to describe, in the rays of light they flash on us from afar, the nature of their elementary structure, and their chemical relations to the earth we inhabit. Scarcely second in importance, perhaps practically of greater value, is the method of analysis by diffusion, on which the Master of the Mint communicated a paper to the Royal Society on the 6th of June last.

For the purpose of propounding this method, Professor Graham divides bodies into two classes,—crystalloids, those which exhibit a tendency to crystallize, and which are of high diffusibility; and colloids, which are of low diffusibility, affect a vitreous structure, and have little effect on the volatility of the solvent. Examples of crystalloids will occur to the mind of the reader in plenty, and it may therefore suffice to state that animal gelatine is the type of the colloids. The peculiar fitness of gelatine and cognate organic compounds for the purposes of animal organization arise from their plastic nature, and the facility with which they become media for liquid diffusion while still retaining their identity. Passing by the suggestion thus offered us, of new modes of investigating the chemistry of life, we will be content here to indicate the process by which the analysis by diffusion is conducted. A septum of membrane is provided, it may be a sheet of gutta-percha paper, or vegetable parchment, eight or ten inches in diameter, by three inches in depth, formed on a hoop, in the fashion of a sieve. A mixed solution, which may be supposed to contain sugar and gum, is placed upon the septum to a depth of half an inch, and the instrument is floated upon a considerable quantity of water. In the course of time, the sugar—a crystalloid—by its high diffusibility, separates from the gum, leaving the gum in an undiffused state remaining on the septum. In another experiment, defibrinated blood charged with a few millegrammes of arsenious acid was found to impart the greater part of the arsenious acid to the water in the course of twenty-four hours. The diffusate was so free from organic matter, that the metal

could be readily precipitated by sulphuretted hydrogen and the quantity weighed. The separating action of the septum by this process is called *dialysis*, under which designation a great revolution will doubtless be effected in the processes of proximate resolution. The applications of this method in judicial investigations, in the detection of adulterations, and in researches into the subtle phenomena of animal and vegetable life, will be of immense value, because simple beyond all precedent in the history of chemical practice. Other, and apparently remote departments of science will be aided by the discovery of dialysis; and we shall not be long in learning that we have in it a talisman to unlock some of the secrets of the molecular structure of bodies.

The conquest of the earth is a work shared pretty equally by the active spirits of every class of action and thought. The explorer and the colonist move in the van, but their efforts are aided by every practical application of scientific theory; and even the recluse lends his aid when deducing from human history and natural phenomena the conditions on which life is possible, and civilization good. But to exploration we look for the preparatory steps, and in 1861 there was much added to our previous stock of knowledge of the physical aspects of the globe. The hills and valleys of Japan have yielded treasures of animal and vegetable life; we know somewhat more of China, much more of Australia, and the African mystery takes precedence of the Asian in modern annals.

At the commencement of the year, we had full particulars of the results of the survey of the North Atlantic, by the party under Captain Young, in the steam yacht "Fox," for the purposes of ocean telegraphy. There was little added thereby to our stock of geographical knowledge, but the soundings brought to light the fact, that at a depth of 7000 feet, and about 500 miles from Greenland, the sea abounds with life, not only of the low order of globigerina, but starfishes and annelids, and boring creatures capable of doing mischief to submerged cables. The like results have followed the investigations of Mr. Gwyn Jeffereys and others, proving how confined have been our views hitherto of the distribution of life on the globe. The Swedish polar expedition, under Mr. Torrell, who is accompanied by the veteran Peterman, has attracted considerable attention, owing to its exploration of portions of the Spitzbergen coast not touched by any of the numerous polar expeditions of the last half century. We may expect shortly an account of the researches of the Expediçao Scientifica of the Brazilian Government in the Amazon district—a region of wonders—so far as that can be rendered in

the absence of the notes and photographs of S. de Capanema, the geologist to the expedition; Professor Allemão, the leader of the enterprise, having abundant material for a representation of the botany and geology of the country. Dr. Livingstone continues his labours with unabated ardour; Sir Robert Schomburgk is gathering information on the products of Siam; Captain Blakiston, who explored the Kootanie Pass, through the Rocky Mountains, three years since, is now penetrating untrodden regions of Central Asia, and will be able to add much to our knowledge of the geography of China; the French expedition to Southern Siberia is at work on the regions bordering the Amoor; and Dr. Beke is on his way to determine the true site of the Biblical Haran, a point considered so far settled already, that there is but small prospect of any important consequences.

Conspicuous among the items of information on the subject of physical geography, are the two recent explorations of the interior of Australia; the one by Mr. Stuart, which was well conducted, and came to a happy end; the other, by Mr. Robert O'Hara Burke, which was wofully mismanaged, and terminated disastrously. We now know satisfactorily that the predictions of the geologists respecting the interior of that vast continent were founded in error. Instead of interminable wastes of sterile rock, broken only by lakes of brine, there are immense tracts of fertile country; mountain chains, whence issue streams that water flowery valleys, and extensive tracts of metalliferous soil. We are only beginning to understand the extent of the resources of the prosperous colonies of Australia, to which we may turn with renewed hope during the present American crisis, believing in the possibility of an abundant supply from thence, of every product for which hitherto we have been so largely dependent on the other side of the Atlantic. The explorations of Captain Sturt comprised, perhaps, the gloomiest and most forbidding regions of the interior; those of Mr. Stuart were from Chamber's Creek to within 250 miles south-west of the Gulf of Carpentaria, from which point he retraced his steps. In the centre of Australia he planted the British flag on a pile of stones, within which was inclosed a bottle, containing a statement of his progress up to that point. The configuration of the surface, and the vegetation during the greater part of the toilsome journey, indicate that there is an almost inexhaustible extent of country fitted for the diffusion inland of the civilization which now prospers on the coast. The expedition under Mr. Burke left Melbourne on the 20th of August, 1860, crossed the continent, and reached the tidal waters of the Albert River, which flow into the Gulf of Carpentaria, and returning

to their depôt at Cooper's Creek. The party consisted of Mr. Burke, commander, Mr. G. Landells, second in command, Mr. W. J. Wills, astronomer, Herman Beckler, surgeon and geologist, Ludwig Becker, artist and naturalist, ten men, and three sepoys. They had camels, horses, waggons, and an abundant outfit. At Menindie a dispute arose, and Mr. Landells left the expedition with Dr. Beckler. Burke then divided the expedition into three parties; and himself, Wills, and six others proceeded to Cooper's Creek, leaving the rest to bring up the stores to the depôt. At Cooper's Creek, Burke again divided his party, leaving three or four to keep charge of the depôt till his return, but about the time they were to wait there was evidently a misunderstanding. Burke then started for Eyre's Creek, 300 miles distant. From this point they proceeded eastward, till they struck the 140th meridian, travelling then due north, till they reached 17° 53′ S., and 139° 49′ E. They next pushed on to the Gulf of Carpentaria. On the 19th of February last, they began to retrace their steps, and on this journey Gray died, after indescribable sufferings. On the 21st of April they reached Cooper's Creek, alas! just seven hours after the party in charge had quitted the depôt on their way to fall back on Menindie. They were now in a helpless condition, and subsisted for a while on the seeds of a plant called nardoo. Burke sank from exhaustion, and died; Wills died next, and King was left alone in the wilderness. He crawled in search of the blacks, and found them; and at last reached Melbourne, the bearer of melancholy tidings. Five others died of scurvy and want, including Dr. Beckler, who is believed to have added to the misfortunes of the party by his adherence to the indefensible cause of Landells. Miserably as this affair ended, such of the journals as have been preserved confirm the statements of Mr. Stuart, that the interior of the continent is diversified with fertile tracts of vast extent, navigable rivers and lakes, and rocky ranges rife with metallic treasures.

The conquest of the earth calls forth the energies of the engineer, the miner, the surveyor, and the merchant, as the proper coadjutors of the astronomer, geologist, and naturalist. Submarine cables have failed in so many instances that we must hope for an entire remodelling of the system under which they have been laid and lost hitherto. The jobbery of dishonoured contracts has brought discredit on the science out of which they originated; interrupted communications by the delusion of supposed improvements in the transmission of intelligence; and caused the hopeless consignment to the sea-bottom of thousands of pounds contributed by too confiding shareholders. It may be a long while yet ere the message of "peace and good-will"

shall be again conveyed from these islands to the remoter shores of the Atlantic, but it will be done, and we have but to wait. Ocean telegraphy is in its infancy, and has been fruitful in infant follies of waste, and error, and perversion; but the sacrifice has not all been in vain, and the promoters of such enterprises are brought back to the old vantage ground of fact, for the necessary basis of their theories. That in other departments science assiduously seconds individual energy, we had a grand example in the transmission of the intelligence from America, of the concession to the demands of Britain in the matter of the "Trent" and "San Jacinto." To such agencies commerce adds her numerous means of help. The closing of the ports of the Southern States of North America has recalled attention to the capabilities of soils and climates where the abuse of slavery is unknown. Now to bridge torrents, establish iron roads through ghauts and marshes, there is opportunity for the engineer to aid, at last, in doing justice to India; and Britain may discover the value of the Oriental gem which has hitherto but faintly sparkled in her diadem of empire. We are promised ships that cannot sink; boats are made in a few hours by machinery; rifled ordnance and plated frigates promise to give the command of the seas to the masters of the forge; and the blasting system of Bessemer is overpassed by the discovery of the part which nitrogen plays in the composition of steel. To bring up the rear in this system of engineering applications, Bonelli's telegraph writes down with equal rapidity the messages that by older systems were only spelt out in arbitrary signs, liable to error and occasional delay. Looking to the gleam of the morning for the promise of the coming day, the prospect brightens and fills us with heart and hope. The learned societies are generally in a prosperous condition. The arts flourish. The means of life abound. Naturalists' clubs and scientific books are on the increase; a higher standard of mental and moral culture is the desire of the English people, and the progress of education among the masses tends to refine popular intelligence, and encourage prudence and thrift, and inculcate that wholesome doctrine that God helps those who help themselves. The statistics of health and mortality increase the force of the conclusions drawn from the last census, that human life has a higher average duration, and is less embittered by avoidable ills; while the resources of Britain expand, and peace is crowned with prosperity. In the forward glance rises, to the broadening sunlight, the grotesque yet dignified façade of the new International Exhibition, where, during 1862, science, and art, and plodding industry will hold peaceful conference on their several abilities to bless the world. While other plans are

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immature that will be the monument—of which he was himself the founder—to that noble Prince whose blameless life was endowed with the genius of active goodness; as it will vindicate, in the face of the world, the famous motto of Lord Bacon, "The true end of science is to enrich human life with useful arts and inventions."

SHIRLEY HIBBERD.

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## PRIME MOVERS.

BY J. W. M'GAULEY,

Author of "Lectures on Natural Philosophy," etc.

We shall briefly examine the most important of those sources of motion which have been either adopted or proposed, and shall compare their respective advantages and defects. The subject is one of great interest; since the cost of every industrial product is affected by the expense of the power which is employed in obtaining it. And, within the memory of many of us, the prices of nearly all the articles in general consumption have been greatly diminished, because the prime movers used in their manufacture have been either changed or improved. Some consequences, which are both interesting and instructive, will follow from our reflections on the subject; ingenuity will be prevented from wasting its energy on contrivances that have been already tried, and have been proved either impracticable or worthless; and the capitalist may decide for himself as to the feasibility of any invention designed to generate motion, so that neither shall his liberality be abused, nor he himself be deterred from lending his aid to the progress of science, through an indiscriminating dread of all new discoveries.

At first, every laborious process was performed by man himself. In the infancy of society, when his wants were few, his subsistence easily obtained, and the calls on his exertions not very numerous, this was attended with but little inconvenience. But, as civilization progressed, he called to his aid the horse, the ox, and other animals; next, he used water-power, afterwards the wind, and finally steam: until at length his occupation was reduced to little more than the superintendence of those gigantic powers which he had pressed into his service. But man is never content with what he *has* done—and it is well that he is not; for this is the source of progress, the origin of every improvement. As long as the human race shall exist on earth, it shall advance in knowledge, and therefore

in *power;* and each succeeding age shall unfold wonders that were not even dreamed of in the preceding. Constant efforts, therefore, have been made to supersede the steam-engine, by some motive power still more convenient or economical. What will be the result of similar attempts hereafter, none can say; for it would be rashness to place a limit to the discoveries of science; but, hitherto, as we shall presently perceive, success has not attended these efforts. On the contrary, time, labour, and ingenuity have been wasted on projects which, being opposed, in many instances, even by physical laws, were utterly impracticable. We shall consider, in succession, the various sources of motive power; directing our attention principally to those contrivances which have been intended, either seriously to modify the present mode of applying steam, or altogether to set it aside.

Although the *strength* of *animals* has been used from the earliest times, we have arrived at but little accuracy, and no uniformity, in our modes of determining even its average amount for any species; and the estimates which have been made regarding it vary considerably. This, however, should cause no surprise; since not only do animals of the same species differ in their capabilities, but the very same animal gives different results, according to the nature of its employment, its intervals of rest, the kind and quantity of its food, and a number of other circumstances. The strength of an animal is equal to "the product of its effort, its velocity, and that part of the twenty-four hours during which the effort is continued." And there is, for each individual, some set of values of these quantities which gives its maximum amount of work. An animal may move so fast, as to be able to move only itself; or, from being overburdened, so slowly, as to produce no useful effect. The proper speed and burden lie between these extremes. An animal may be employed either in carrying, in pushing, or in drawing. A man will carry, on a horizontal plane, eighty-five and a-half pounds, for seven hours a-day, two feet and four-tenths per second; which is equivalent to 5,171,000 pounds carried one foot. He will draw with a force of from seventy to eighty pounds on the level ground; but will push at the height of his shoulders with a force of only about twenty-seven or thirty pounds. He can ascend a flight of steps, unburdened, at the rate of twelve twenty-fifths of a foot per second, which—supposing him to be of average weight—is equivalent to 1,935,000 pounds lifted one foot, or only two twenty-fifths of what he could do, moving horizontally.

Of all animals, the horse is best adapted for labour. And, since he uses his weight to overcome resistance, his efforts are most effectively exerted in drawing a load on a horizontal surface. Watt considered that a horse could raise only 33,000 lbs. one

foot high, per minute; and this is the standard which has been adopted in estimating the power of steam-engines. It is equivalent to 15,840,000 lbs. raised one foot high in a working day of eight hours. According to Gerstner, the following represents the work done by the different animals:—

| Animals. | Pounds Weight. | Mean Effort in Pounds. | Mean Speed per Second. | Hours per Day. | Pounds per Second. | Effect per Day. |
|---|---|---|---|---|---|---|
| Man ..... | 150 | 30 | 2·5 | 8 | 75 | 2,160,000 |
| Draught-horse ... | 600 | 120 | 4·0 | 8 | 480 | 13,824,000 |
| Ox ..... | 600 | 120 | 2·5 | 8 | 180 | 8,640,000 |
| Mule ..... | 500 | 100 | 3·5 | 8 | 350 | 10,080,000 |
| Ass ..... | 360 | 72 | 2·5 | 8 | 180 | 5,184,000 |

A horse, on the authority of Desaguliers and Smeaton, is usually considered as equivalent to five men. Bossut reckoned an ass as equivalent to two men.

The power of animals is derived from the combustion which is carried on in their bodies; and the heat derived from this source was originally absorbed from the sun's rays during the growth of those plants which, mediately or immediately, form their food. And hence, in reality, their force is derived from the SUN.

Having availed himself of the strength of animals, man was a long time before he perceived that he might obtain a motive power from water. Hand-mills, termed *querns*, were used for grinding corn long after the still ruder method of pounding it had been wholly, or in part, discontinued; subsequently these were fitted with shafts, and cattle were attached to them; but, as Strabo informs us, water-mills were not introduced at Rome until about seventy years before the Christian era. It has been estimated that a ton and a-half of water per minute, falling one foot, will grind and dress a bushel of wheat per hour. The cost of putting up any hydraulic machine is nearly the same as that of a steam-engine of the same power; but the force derived from it is less expensive.—The power obtained from rivers and streams, also, is derived from the SUN. For the water is raised, during evaporation, by the sun's rays; and produces its effect, while falling back to its original position.

A vast force is generated by the rising and falling of the water which constitutes the tide; and it has, in a few instances, been turned to a practical use, by means of *tide-mills*.—The motion obtained in this way, however, forms an exception, not being derived from *heat*, but from the attractive action of the sun and moon.

The force of the *wind* was applied very early to the propulsion of ships; but it was not employed to drive machinery until a comparatively recent period. Wind-mills are said, by some, to have been invented in France, in the sixth century; it has been asserted by others that they were known in Greece and Arabia in the seventh century, but were first introduced into these countries during the Crusades. They have been very commonly used, particularly in Holland, for drainage; but their frequent stoppage for want of wind, and the difficulty of regulating their speed, has been a serious obstacle to their adoption in most manufactures.—The force obtained from the wind, also, is derived from the SUN: which, by rarefying the air in distant regions, causes atmospheric currents to be produced.

Before entering on the subject of steam-engines, and their proposed substitutes, it will be useful to glance at a few of the properties of Heat, which, with the one exception we have mentioned, is probably the source of all our motive power. Heat is employed either to cause an increase of temperature, in which case it is said to be *sensible;* or to produce mechanical changes, in which case it is termed *latent.* The work which is lost by friction is always expended in the development of heat; and hence it is supposed, that the friction of a piston against the sides of a steam cylinder causes no diminution in the power of the engine, since the heat which is set free raises the temperature of the steam, and therefore augments its pressure. The effect producible by 772 pounds falling one foot, is considered to be the quantity of work, corresponding with the heat, which would raise a pound of water, at the ordinary temperatures, through one degree Fahrenheit; and this quantity has been termed "Joule's unit." When a body returns to its original condition—steam, for example, to water—heat disappears, and to an extent equal to that which would be generated by employing the force thus produced in overcoming friction. This is called "the conversion of heat into mechanical energy." And the efficiency of the heat, in a heat-engine, depends on the relation between the heat converted into mechanical energy, and the whole heat applied. It is probable that the efficacy of all prime movers, without exception, is proportional to the heat so converted. The efficiency of a steam-engine depends on that of the furnace, or the effect of the steam upon the piston, and on the power communicated by the piston, through the crank shaft, to the machinery; but nearly one-fifth of the heat is expended in causing a draught in the chimney, and a large quantity besides is lost by radiation from the various parts.

There is great reason to believe, that all sources of power yield the same amount of it, with the same quantity of heat; and that the only thing we can do is to discover in what

XUM

machine the amount of heat expended in work approaches the nearest to equality with the entire quantity.

The same substance, in the solid state, has less capacity for heat than in the liquid state; and, in the liquid, less than in the vaporous state; but combustion may change a solid, or a liquid, into a gas which has a less capacity for heat; and the heat given out by fuel is the difference between its specific heat and that of the products of its combustion. Charcoal, when burned, takes oxygen from the atmospheric air: and, as that gas is rendered more dense, without alteration of its volume or elastic force, it loses the difference between its specific heat in its former and its latter state. It was found, as the mean of several experiments, that one pound of hydrogen, combining with oxygen, is capable of raising 51,146 pounds of water, one degree Fahrenheit; one pound of carbon, 14,500 pounds of water; one pound of phosphorus, 11,900 pounds of water; and one pound of sulphur, 2800 pounds of water. But hydrogen, during combustion, combines with *eight* times its weight of oxygen; carbon, with only *twice and two-thirds* of its weight; phosphorus, with only about *once and a quarter* its weight; and sulphur, with only *an equal* weight. The heat evolved has, therefore, a very close relation to the amount of oxygen which enters into combination. We may deduce the heating power of any kind of fuel from these quantities, if we know the nature and relative amounts of its constituents; since all fuel consists chiefly, or altogether, of carbon, of carbon and hydrogen, or of carbon, hydrogen, and oxygen. There is a loss of heat, by vaporization of water, whenever that fluid is formed during combustion; and this loss is estimated at one-fifth of the power of the hydrogen—any water, mechanically present in the fuel, would, of course, be a cause of further diminution. The heating powers above mentioned suppose the combustion to be complete; but if, from any cause, it is imperfect, the carbon may be only partially consumed—dense smoke being generated; or it may combine with only half the quantity of oxygen; in which case the thermal unit falls from 14,500 to 4400 pounds of water. Hydrogen unites with pure oxygen at 800°, and burns in the atmosphere at 950°; carbon unites with pure oxygen at 700°, and burns in the atmosphere at 800°; but when the fuel contains incombustible gases, higher heats are required; and if the temperature should exceed 1200°, particularly if it approach 1500°, carbon, combining with the earthy matters found in ordinary coal, will form clinkers, and fuel will be wasted.

The heat of all fuel is that which has been received from the SUN, during the chemical changes which take place in the growth of those plants that constitute not only the forests at

present in existence, but those forests also belonging to a remote period, to which our coal-fields owe their origin. There is no fuel which is not derived from one of the organic kingdoms—none, indeed, which has not had its origin in plants, at least preparatory to its having entered into animal organizations. It is probable that, during combustion, the *supporter* takes the place of combined caloric, which therefore is evolved. Hence, when carbon becomes carbonic acid, heat is set free; but when carbonic acid is decomposed in any way, heat is absorbed.

We have reason to believe that the ancients knew more about steam than is usually supposed; and the mistake on this point may have arisen from their terming steam "air." There is no doubt that steam, and air expanded by heat, were used by them for producing motive power. Hero, of Alexandria, who flourished about B.C. 120, discusses the properties of *air*, as a medium for communicating pressure and motion; and enters into the nature of a vacuum—subjects which comprehend the whole theory of the steam-engine. But, long as the properties of steam have been known, and much as they have been studied, the greatest actual efficiency of the steam-engine is still but about one-sixth of its theoretical; that is, but one-sixth of what its efficiency ought to be, taking into account the heat which is expended in working it. Besides other sources of loss, steam is wasted, in heating the cylinder, during the first part of the stroke; which is necessary, from the cooling of the cylinder, during the expansion effected in the latter portion of the preceding stroke. And not only is the steam, which has been condensed from this cause, only partially revived afterwards, but its revival becomes, in some degree, mischievous; since it continues, while the exhaust steam is passing into the atmosphere, on the condenser; and thus, by increasing the "back pressure," it lessens the power of the engine. The loss, from this cause, particularly with high velocities, and great expansion, is so serious, that it very much diminishes and sometimes altogether destroys the advantage derived from using the steam expansively. Some steam, also, is condensed behind the piston, owing to the conversion of part of the heat into work, and the consequent precipitation of water. This, in itself, is not a loss; but, during the latter part of the stroke, it robs the cylinder of heat, and the steam, thus condensed, and afterwards revived, being formed too late, increases the *back pressure*.

It was supposed that a large quantity of the heat, which is carried off by the waste steam, might be retained; and the *Regenerative steam-engine* was designed to effect this object.—A furnace, placed under the cylinder, heated the steam to a temperature higher than the boiling-point corresponding with its

XUM

pressure; and a *respirator*, or apparatus capable of rapidly absorbing or imparting heat, was employed. The steam, in passing off to the atmosphere, through the respirator, left a large quantity of heat behind; and this was taken up by the steam which next entered the cylinder. It was asserted that, with this engine, only one-twentieth of the effect was lost; but it is nearly the same in principle, and is open to almost the same objections, as the *caloric* engine, which we shall notice presently.

A belief that the *crank* destroys power, has caused many efforts to construct *rotary steam-engines;* that is, such as would produce a rotary motion, by the *direct* action of the steam, and without the medium of reciprocation, which is unavoidable in ordinary engines. This belief, however, is shown, by the properties of the lever, to have no foundation: a certain amount of force is, no doubt, lost on account of obliquity of the connecting-rod; but this loss is far more than counterbalanced by the advantages of the crank, which gradually brings the heavy masses of matter to a state of rest, or motion; and by the diminished speed it causes towards the end of the stroke, which gives time for the waste steam to escape before the piston returns upon it.—The first rotary steam-engine, of which we have any account, was that invented, or at least described, by Hero, of Alexandria, in the second century before the Christian era. The steam was made to escape from apertures, near the ends, and at opposite sides, of a hollow arm which turned about its centre; the reaction against the interior of the tube, opposite to the apertures, caused a rotatory motion. Its principle has been applied in engines constructed by Avery, in America, and by Ruthven, in Edinburgh; and it is one of those contrivances which have often been reinvented; but it is less efficient than the common engine, since the steam leaves the revolving-arm with a higher velocity than that of rotation.

In other forms of rotary engine, the steam produces a continuous motion, by causing vanes, etc., to revolve within a drum; but it has been found impossible to keep such surfaces steam-tight.

The attempts made to obtain a more economical, or, at least, a more convenient prime mover than steam, have given rise to many proposed substitutes for it; but none of them have been successful. If any machine shall supersede the steam-engine, it must be "cheaper and as good," or "better and as cheap." However ingenious it may be, unless it fulfils one, at least, of these conditions, it has no chance of being adopted.—We shall first direct attention to what has been proposed, rather as improvements of the ordinary engine, than as different sources of motive power.

The *steam and ether engine* was intended to economize the heat which is wasted in the condenser, when the steam is changed into water. Few attempts to improve the steam-engine have excited such sanguine expectations; and the invention was actually purchased by the French Government, on the recommendation of eminent French engineers, who estimated the saving it was supposed to effect at seventy-four per cent.; even Rennie, who seems to have examined it carefully, considered it to save seventy per cent.—Ether was evaporated, by the heat given out in condensing the steam of an ordinary low-pressure engine; and the resulting ether vapour was employed to move a piston. It was assumed, that all the work done by the ether was so much gained; but, among other inconveniences, the evaporation of the ether was found incompatible with condensation of the steam, at a sufficiently low temperature; and the effect derived from the steam was, therefore, less than it should be. Without great care, also, there was danger of ignition or explosion, with the ether vapour; and ether was unavoidably wasted.

It was supposed, from the very low temperature at which certain fluids boil, that they might be used, with the steam-engine, more advantageously than water. Thus, while the latter, under ordinary pressure, boils at 212°, alcohol boils at 175°, and ether at 112°. And, as the elastic force of the vapour produced is, in each case, the same, it was considered that the vapour of alcohol, ether, and other fluids which boil at comparatively low temperatures, might be used in producing motive power, more economically than that obtained from water. Their boiling points being lower, they can be evaporated with less expenditure of fuel; and from this it was assumed that, at a given cost, they would do much more work. This reasoning was extremely plausible; nevertheless it was found that the vapour of water, though produced at a higher temperature, is more economical than that of any other fluid. The reason is a very simple one: the mechanical effect of a vapour depends, not only on its pressure, but also on the distance through which that pressure is exerted. Now, as a cubic inch of water, at 212°, produces one thousand six hundred and ninety-six cubic inches of vapour: while a cubic inch of alcohol produces only six hundred and sixty, and a cubic inch of ether, only four hundred and forty-three: it follows that, to fill as much space as is occupied by the vapour obtained from *one* cubic inch of water, nearly *three* cubic inches of alcohol, or *four* of ether, must be evaporated. And hence, the motion of a piston through a given distance is produced far more cheaply by the evaporation of water, than by the evaporation of alcohol, or ether. The same is true with regard to every other liquid that has been tried—and, we may reasonably suppose, with

regard to any whatever: much more being lost, by the additional quantity required to be evaporated, than is gained by the lower temperature at which the evaporation takes place. In reality, the effect produced by any vapour depends on the amount of heat which is necessary for its production: and this, for water, alcohol, and ether, are as follows.—

| | Specific Gravity. | Boiling Point. | Heat of Conversion into Vapour. |
|---|---|---|---|
| Water..... | 1·000 | 212° | 942° |
| Alcohol ..... | 0·825 | 175° | 425·5° |
| Ether ..... | 0·700 | 112° | 302·6° |

Cagniard de la Tour reduced alcohol, spec. grav. 0·837 at a temperature of 497°, to a vapour having a calculated pressure of one hundred and nineteen atmospheres; but it occupied a space not quite *three* times its original volume. He converted sulphuric ether, at 392°, into a vapour having a pressure of nearly thirty-eight atmospheres; but it occupied a space not *twice* its original volume. At 497°, water exerts a pressure of about forty-four atmospheres; and occupies a space about *ninety-nine* times its original volume. At 392°, it exerts a pressure of about fifteen atmospheres; and occupies a space about *one hundred and forty-one* times its original volume. Sulphuret of carbon has an elastic force equal to about four atmospheres, at 212°; and to nearly twenty-nine atmospheres, at 392°; but it is liable to the same objections as alcohol and ether. Oil gas vapour, which is produced from the liquid that is separated from oil gas by the pressure used to render it portable, was suggested, by Tredgold, as perhaps very suitable to supply the place of the vapour of water in a steam-engine; it boils at 170°, and remains liquid at common temperatures. But there can be no doubt that the mechanical effect of its vapour, also, is dependent on the quantity of heat absorbed in passing from the liquid to the vaporous state—this being most probably a general law.

The remarkable expansion of carbonic acid and other gases, when liquified, very soon attracted notice. Sir H. Davy expected that it would afford a mechanical agent, on account of the immense difference between the increase of elastic force in gases under high and low temperatures, by similar increments of temperature. The force of carbonic acid at 12°, was found equal to that of air compressed to one-twentieth of its bulk; and at 32°, to that of air compressed to one thirty-sixth; making an increase of pressure equal to thirteen atmospheres. It was ascertained by Thilorier, that the pressure of the vapour

formed by liquified carbonic acid from 32° to 86° Fahrenheit, amounts to from thirty-six to seventy-three atmospheres; and the volume from twenty to twenty-nine—the expansion being four times that of atmospheric air. But Davy did not remark that the space through which the pressure is exerted is inconsiderable. The less the specific gravity of a vapour, compared with that of the fluid from which it is produced, the more effective it will be as a mechanical agent; but the specific gravity of steam is less than that of any vapour which has been tried, not only when compared with liquids, such as alcohol, etc., but with liquified gases also; as will appear from the following:—

| Liquids. | Spec. Grav. of Vapour. | Spec. Grav. of Liquid. | Temperature. | Mechanical Effect. |
|---|---|---|---|---|
| Sulphurous Acid ..... | 2·777 | 1·42 | 45° | 426 |
| Sulphuretted Hydrogen ..... | 1·192 | 0·9 | 50° | 630 |
| Cyanogen ..... | 1·818 | 0·9 | 45° | 395 |
| Ammonia ..... | 0·5962 | 0·76 | 50° | 1057 |
| Chlorine ..... | 2·496 | 1·33 | 50° | 440 |
| Water ..... | 0·48 | 1·000 | 212° | 1711 |

The *gas engine* was intended, by Brunel, to apply to practical purposes the power expected from the expansion of liquified gases; and it must be a source of wonder and regret, that so enlightened a man should have wasted his ingenuity on so hopeless a project. He placed liquified carbonic acid in two receivers; and when these were heated and cooled alternately, the resulting expansions and contractions were made to communicate motion to a piston, working in a cylinder, which was placed in an intermediate position. A rise of 180° gave a pressure of ninety atmospheres; which, having no resistance to overcome, except that of the vapour in the other receiver, at a lower temperature, tended to move the piston with a force estimated at sixty atmospheres. The pressure was undoubtedly very great; but the distance through which it acted was trifling. Brunel constructed an eight-horse engine on this principle.

It was hoped that a boiler, furnace, and all their attendant inconveniences would be rendered unnecessary, by using explosive gases instead of steam, for the production of a vacuum; and the *gas vacuum* engine was patented for this purpose in 1824. The air was rarefied alternately in two chambers, by burning coal gas within them; water, which was then forced up by atmospheric pressure, was used to turn an overshot wheel. The inventor proposed applying this principle to the movement of a piston in a cylinder; but the contrivance would then be

XUM

liable to the objections which are fatal to that we shall consider next.

It was expected, that not only might a vacuum be produced by explosive gases, but that a motive power also might be directly obtained from it. The *ignition-gas engine*, which was intended to carry out this object, was invented many years since, and was re-invented about five years ago in America. It is at present being tried as a new invention in France, by M. Lenoir.—An explosive mixture, consisting of hydrogen, or some of its compounds, and common air, is ignited by electricity or other means, in a cylinder, the piston of which is impelled by the expansion and subsequent contraction produced by combustion. One measure of hydrogen and two and a-half of common air expand, during explosion, to *three* times, and then collapse to *one-half*, of their original bulk. Several years since, this engine was characterized as "violent, vacillating, and noisy," and it must necessarily be so. Such a principle cannot be successfully applied; the *inertia* of matter renders it impossible for machinery to be effectually moved by sudden and transient impulses, such as those which are the result of explosions. To move a material substance, particularly if it is of considerable weight, the power must *continue* to act upon it for some appreciable time. Even gunpowder may be so manufactured as to explode too rapidly for the production of a proper effect on the ball. A door, which may be easily closed by gently pushing it with the finger, will move very little, or not at all, when struck suddenly or violently with the hand; and, the more violent the blow, the less it will move. Other explosive mixtures, including gunpowder, have been tried, with similar results.

The substitution of heated air for steam was proposed, in 1816, by Stirling; and, about twenty-five or thirty years ago, air, expanded in an iron cylinder, which was kept at a red heat, was used for giving motion to a piston. But, as in all the experiments of this kind which have been made, it was found that the cylinder was soon destroyed by the high temperature. In *Ericsson's caloric engine*, which was constructed on this principle, and caused so much excitement some time ago, in America, there were two larger and two smaller cylinders—a smaller being placed above a larger, and the pistons of both being made to move together. The air passed from the smaller or *supply* cylinder, through a *regenerator*, where it was heated to about 450°, to the larger or *working* cylinder, where its temperature was raised to 480°, by a fire placed underneath. The regenerator—to which the name of *respirator* was given, in the *regenerative steam-engine*, mentioned above—was a vessel, in which sheets of wire gauze were placed side by side, so as to form innumerable cells, through which the air was made to

pass. The air which left the working cylinder at a high temperature imparted to the wire gauze most of its heat, and this was taken up by the air passing through it to the working cylinder; that side of the regenerator which was next the latter being always very hot, and that at which the cold air entered being always comparatively cool. The excess of pressure on the piston in the working cylinder, above that on the piston in the supply cylinder, constituted the power. When the air was heated to 480° its volume was doubled, so that the pressure per inch on each piston was the same; but as one of them had twice the surface of the other, it was acted on by a double pressure. It was asserted that, with this arrangement, only one-tenth of the entire heat was wasted. But any apparatus, capable of depriving steam, or air, of its heat, *in transitu*, must retard its progress, and therefore must diminish its effect. The bad conducting power of air must cause it to absorb or relinquish heat slowly, and with difficulty. And the cylinders required are enormous: in Ericsson's sixty-horse engine, the larger were *six* feet in diameter; and in his marine engine, *fourteen*.

The extraordinary force exerted by *electro-magnets*, suggested electro-magnetism as a moving power. The writer of this article, some years ago, made a great number of experiments on this subject;* and he was led to the conclusion that certain properties, which he had found in combinations of electro-magnets, would always prevent their application in any useful way. All the experiments that have since been made with them, have established the soundness of the reasons on account of which he abandoned the attempt. A superficial view of the matter would lead to the impression that an electro-magnetic engine must be more efficient than a steam-engine of equal cost. But the expensive nature of the material it consumes, the complication of its machinery, the diminution of its power, by circumstances which cannot be avoided; and in many cases the uncertainty—we might almost say the capriciousness—of its action, must ever leave it very inferior to the steam-engine. And its warmest advocates have long since acknowledged† that, on the score of economy, electro-magnetism can never compete with steam. Indeed, the French Government, when it offered a prize of £2000 for a successful electro-magnetic engine, required only that it should not consume more than half a kilogramme, or about seventeen and a-half ounces, of zinc per horse-power per hour: in France this would cost tenpence, in England less, but much more than the same amount of steam-power. It is not difficult to show

* See Reports of the British Association for 1835, 1836, etc.

† Page's Letter to the Government of the United States in 1850.

that it *must* be more expensive to maintain an electro-magnetic engine in action, than a steam-engine capable of doing the same work. One grain of zinc was found to raise only *eighty pounds* one foot high; but one grain of coal, in the furnace of a Cornish engine, will raise *one hundred and forty-three pounds*, through the same distance. The cost of one hundred-weight of coal is *nine* pence, that of one hundred-weight of zinc about *two hundred and sixteen* pence. Hence, electro-magnetic power is nearly *fifty times* as expensive as that obtained from steam. It has been asserted by Liebig, that the zinc of the battery cannot give out more power than the coal required to smelt it; and that the *heating* power of a galvanic battery is the equivalent of its *mechanical* power; so that, if applied to the vaporization of water, the steam produced by the heating power would do as much work as can be expected from its application to an electro-magnetic machine. Favre has shown that the heat liberated from a galvanic battery is proportional to its chemical action; and that the mechanical work performed by the current always incurs an expense of the heat, borrowed from that which is evolved by the battery. It is worthy of notice that when an effect opposite to the magnetic attraction is produced —as, for instance, when magnetized bodies are forcibly drawn asunder—the heat is augmented. It has been ascertained that, using "Joule's unit," one pound of zinc consumed in a Grove's battery would, if the heat were utilized, raise 1,698,000 pounds one foot high; and one pound consumed in a Daniell's battery, 1,019,000 pounds. But 1,698,000 pounds raised one foot high, are equivalent to only one-horse power, during fifty-one minutes. These, besides, are the maximum *theoretical* effects; but, from the imperfect nature of the electro-magnetic machine, nothing like them are really attainable. If, as Joule supposes, heat is changed into mechanical effect during the action of the engine, the maximum power of even a perfect electro-magnetic machine must be far less than is produced with the same expenditure, by steam. Liebig observes that, according to the experiments of Despretz, six pounds of zinc combining with oxygen give no more heat than one pound of coal; and that, therefore, the coal should produce six times as much power as the zinc. We may remark that the heat given out by the zinc was that with which it combined during smelting, and was obtained from the fuel. It would follow that the power of the electro-magnetic machine is derived from the same source as that of the steam-engine, but is not obtained so directly.

It has been replied to some of these facts that electricity, and not heat, is required for electro-magnetism. But that galvanic battery which produces most heat—a single cell of large size—produces also most electro-magnetism. And in-

tensity is required, only because of the resistance which a great length of wire offers to the current. If heat and electricity are not merely modifications of the same element they are certainly most intimately connected, and are always found associated.

Besides all this, the force of electro-magnets diminishes rapidly through space. One which retained two hundred pounds in contact, at one-fiftieth of an inch, lifted only forty pounds and a-half, or about one-fifth. Also, the disturbance caused by the motion of the electro-magnet, or of its sub-magnet, greatly diminishes the power. A magnet which, when free from disturbance, possessed a force of one hundred and fifty pounds, fell to one-half when the sub-magnet, or armature, was made to revolve near its poles. Moreover, the very change of the electric current causes a diminution of its effect: since the secondary current which is generated moves in a direction opposite to that which produces the required motion. Time also is necessary for magnetization; and on account of the secondary current, for de-magnetization also.

Experiments in electro-magnetism as a motive power, have been made on a scale large enough to leave little uncertainty regarding it; governments and public bodies having, in some instances, granted liberal aid to the experimentalist. Page received twenty thousand dollars, or about four thousand pounds sterling, towards the expenses of his experiments. The most sanguine hopes of a successful result have been frequently entertained.—Jacobi, in 1839, propelled a boat on the Neva; but he obtained only one horse-power from *twenty square feet* of platina battery surface. Davidson, in 1842, ran a locomotive, weighing five tons, on a railway near Glasgow: but with a speed of only five miles an hour, which was equivalent to one horse-power, yet he required *seventy-eight pairs* of thirteen-inch plates of iron and amalgamated zinc. Page, in 1850, reported to the United States Government that he had then succeeded in obtaining, at the rate of one horse-power, during twenty-four hours, for twenty cents, or about tenpence British; and he stated, in a subsequent letter, that he had constructed a ten-horse engine. Nevertheless, it was announced some time after, by one of his friends, that he had given up the experiment, as the twenty thousand dollars, and a large sum besides, had been expended on it. His engine was an ingenious and powerful development of De la Rive's ring; and when one of his large helices was magnetized, three hundred pounds weight of iron, which had been placed within it, was lifted up by the magnetic power, and, as long as the electric current was transmitted, remained suspended in the centre—realizing the fabled suspension of Mahomet's coffin. Allen's electro-magnetic engine was inspected by the present Emperor Napoleon,

and was exhibited, by his desire, at the *Conservatoire des Arts et Métiers;* he even appointed a commission of scientific men to examine and report upon it, being, as was stated, so pleased with it that he intended to purchase the invention. But, like every preceding attempt, it ended in nothing.

We have now, as far as our limits would permit, noticed the various sources from which motive power has been, or was expected to be, derived. Every experiment that bears on the subject seems to indicate that all motive power is ultimately reducible to *heat,* or at least is proportional to it. And, if such be the case, the only useful object for which our experiments can be made, would be to discover the most economical means of obtaining, and the most effectual mode of applying, heat. One important conclusion follows from what has been said, that if it is not absolutely impossible to discover a prime mover which shall supersede steam, success is so difficult, and beset with so many obstacles, that prudence suggests great caution, both in contriving and adopting any principle or machine having this for its object. On the other hand, it is clear that excellent as the steam-engine undoubtedly is, only a small portion of the heat required by it is effective in producing motion; and, therefore, it affords abundant opportunities for ingenuity to distinguish itself, and for enterprise to secure profit, in further perfecting its details.

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## ON FLUKES.

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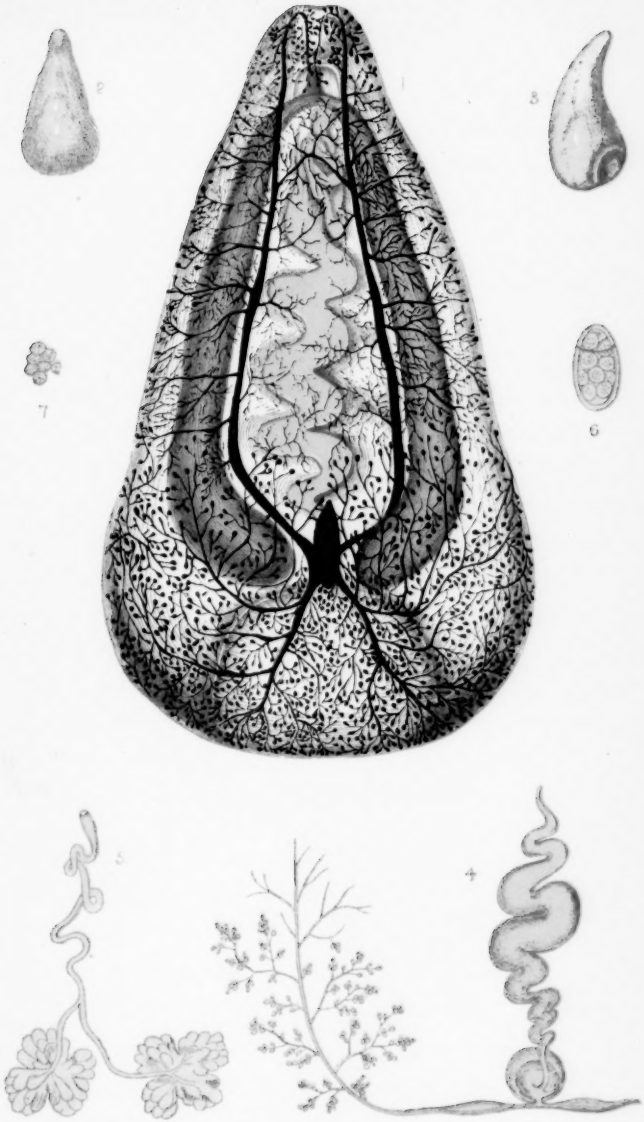
FLUKES constitute a numerous group of diminutive beings who enjoy the privilege of snugly ensconcing themselves within the interior of other living animals. That eminent parasitologist, Alexander von Nordmann, well expressed the unpleasing sensations which pervade the human mind when first induced to contemplate the curious variety of creatures destined to inhabit so strange a dwelling. "Who," he exclaims, in the opening section of his valuable *Mikrographische Beitrage,* "who that did not witness the fact, could possibly have believed that Nature had formed living animals to grope for their existence in the interior of other beings so advanced in the scale of organization, not only, indeed, in the higher, but even in the highest! Nevertheless, such is the case. Man shrinks when he first hears of it; he stands aghast



Amphistoma conicum.

when he first beholds it; and words fail to express the peculiar feeling of awe and aversion of Nature which creeps over him when he discovers the thing, that appeared to him incredible, to be a simple matter of fact."

Nearly thirty years have elapsed since the Russian professor penned this prologue, and it must be conceded that our recent helminthological discoveries have, as yet, done little calculated to chase away such prejudice from the public mind. Perhaps, of all the paradoxes enunciated by creative wisdom—in so far as they affect the economy of organic being—none are more likely to excite astonishment than the truths which demonstrate the curious phenomena of parasitic life; yet, we make bold to number ourselves with those who believe in "necessary evils," and in the following pages undertake to show how a nearer acquaintance with the objects of our study can impart that "enchantment to the view" which is commonly regarded as an effect of distance.

The first group of parasites to which we invite attention are the "flukes," as they are popularly termed; but not unfrequently we shall speak of them as trematodes, or *Entozoa* of the order *Trematoda*, which signifies that they are *internal* parasites, suctorial worms, or helminths, generally characterized by the possession of certain pores or openings. The Greek word, τρηματωδης, from which the ordinal title is derived, means *perforate*. Other parasites, it is true, display a variety of openings and sucking disks, but we shall find them associated with several distinctive peculiarities, into the consideration of which it were now a loss of time to enter.

Flukes are not parasitic during the entire period of their existence, for whilst passing through the cycle of their life-development, they frequently change their residence, at times inhabiting either open waters or the dewy moisture of low pasture grounds. Their strange migrations, active and passive, from parasitic to non-parasitic abodes, will be discussed hereafter. In the adult condition flukes abound in all classes of vertebrated animals; that is to say, in fishes, reptiles, birds, and mammals.

To convey a more precise idea of their distribution, we may observe that flukes are sparingly found in man and monkeys. They are still less frequent in the higher carnivora; none, to our knowledge, having hitherto been detected either in the lion or the tiger. In the common cat, however, two species are known, one proper to its wild, and the other to its domesticated state. Only a few infest the dog and fox, and they are almost entirely absent from the civets and ichneumons; the exception to the rule occurring in the Indian Viverra, in the lungs of which the writer has discovered a small species.

Flukes are abundant in the nocturnal bats; they are scarcely

less so in the insectivorous moles and shrews, whilst at least three distinct forms traverse the body of the unfortunate hedgehog. As yet, none have been descried in the bears, properly so called, but a single species is known to infest the closely allied badger. Weasels and others are peculiarly liable to invasion, and the same may be said of the amphibious seals. Among the herbage-loving rodents the squirrels and marmots are not usually subjected to their attacks; but an Italian, named Targione Tozzetti, is said to have detected the common liver-fluke in our familiar *Sciurus vulgaris*. Even rats and mice are tolerably free from trematodes, yet they harbour an immense variety of other helminths. Flukes, like ourselves, rejoice in the flavour of hares and rabbits, but they utterly repudiate a residence within the body of the uninviting sloth. Our domesticated quadrupeds, such as the horse and ass, are seldom troubled with their presence; but swine, on the other hand, are peculiarly annoyed in this respect. Speaking generally, they are prevalent in all ruminating herbivores, being grievously numerous in sheep and cattle.

Turning our attention to the feathered tribes, on the whole it may be said that flukes are scarcely less abundant in birds than in mammals. Hitherto we have not met with them either in the flesh or viscera of pigeons, parrots, or even in the insect-eating woodpeckers; but, as might be expected, they are of remarkably frequent occurrence in the alimentary canal of gulls, herons, stalks, cranes, plovers, ducks, and other water birds.

Flukes readily gain admission within the bodies of the cold-blooded reptiles, and display an abiding partiality for the batrachian frogs and toads. In the water-loving salamanders they occur less numerously; and in the saurian, chelonian, and ophidian orders they are comparatively unknown. In members of the piscine class they are almost always present, being markedly plentiful in the stickleback, minnow, tench, perch, pope, bullhead, mackarel, trout, salmon, ling, burbot, turbot, flounder, lump-fish, sander, and dorado; and still more so in the perch, pike, barbel, bream, eel, sole, sun-fish, and sturgeon.

A contemplation of these cursorily recorded facts can scarcely fail to suggest several peculiarities respecting the distribution of these creatures. That worthy helminthologist, Carolus Asmund Rudolphi, to whose investigations we owe so much, long ago remarked that the entozoa constituted a distinct *fauna*, or, in other words, a special collection of animals whose country is the circumscribed region of the interior of living beings. We may carry the simile further, and compare each creature thus infested to an island home, whose parasitic inhabitants having a tendency to roam, not unfrequently visit adjacent isles, that is, the bodies of other animals. Taking a

wider view in the matter, it is obvious that the distribution of internal parasites, throughout *space*, must be co-equal and co-extensive with the geographical range of the animals in which they dwell; and it also follows that they will have acquired a corresponding distribution in *time*. Their bathymetric position or distribution in height and depth in relation to our planet, will also accord with that of the infested creatures; in short, the length, breadth, and area of their geological and geographical range will be identical with that of the vertebrate groups whose individual members they inhabit.

This subject becomes yet more strikingly suggestive when we take into consideration the complicated facts and phenomena which the various phases of parasite development unfold; for during their larval wanderings in search of a final resting-place which shall prove suitable to their adult condition, they provisionally occupy the bodies of different kinds of evertebrata; and in order to complete the genetic cycle of the parasite's life, there must needs be, of course, a contemporary existence of both vertebrate and evertebrate types, a concurrence which surely no reasonable person would ascribe to fortuitous circumstances. Further into this speculative inquiry we do not now enter, having purposely suspended our record of the origin, growth, and migration of the young flukes, until we have discussed the features of their adult structure. Meanwhile, however, it is but fair to acknowledge that we have diligently sought for a more practical evidence of the existence of internal parasites in ancient times. This we have done by scraping down portions of fossil excrement, and submitting them to microscopic observation, in the hope of possibly stumbling upon a parasite's hook or spine. Success in this experiment would have enabled us triumphantly to vindicate the force of our persuasion as to their pre-adamite creation; but as the question now stands, few naturalists can doubt their former prevalence. Of course, a searching like the above, can hardly ever prove effective, for the delicacy of their tissues, the minuteness of their bulk, and more particularly, the extreme rarity of their being mixed up with the eliminated products of the alimentary canal, are considerations which almost warn us of the hopelessness of such investigation. If, however, real cololites, or fossil sections of the digestive tube of any of the larger extinct vertebrates could be obtained, then we should not entirely despair of recording ocular proof of the occurrence of Entozoa in the secondary and tertiary epochs.

In regard to the number of existing species of Trematoda, no very accurate estimate can be formed. The writer of this article, not very long ago, made a special investigation, partly with the view of determining this point, and the results of this

inquiry are embodied in a lengthened "Synopsis of the Distomidæ," published in the fifth volume of the "Journal of the Proceedings of the Linnæan Society." In that communication 344 different species of flukes were recognized; and of these, 126 are proper to fishes, 47 to reptiles, 108 to birds, 58 to mammalia, and 5 to non-vertebrated animals. This list, however, does not include certain leech-like forms of fluke (such as are described by parasitologists, under the generic titles of *Tristoma*, *Polystoma*, *Gyrodactylus*, and the like), the greater part of which ought rather to be considered Ectozoa than Entozoa, inasmuch as their habit is to attach themselves to the external surface of the bodies of the creatures they attack. No doubt, in the above record, many immature forms have been regarded in the light of distinct species by the older authors; but when, on the other hand, we take into consideration the additions which have been recently made—especially by Professor Molin of the University of Padua and by the writer himself—and also the probably much larger number of forms which remain undiscovered, it becomes evident that, at the very lowest estimate, we may assume the order Trematoda to comprise five hundred species.

Flukes are small animals, usually visible to the naked eye, but seldom attaining any very significant bulk, some of the minutest forms scarcely exceeding the $\frac{1}{100}$ of an inch in longitudinal diameter. The species most commonly known (*Fasciola hepatica*) is capable of attaining a length of rather more than an inch, and there are four other flukes whose measurement is considerably beyond this. These four notables, deserving special mention, are the following:—

1. The *Distoma crassum*, fourteen of which were discovered by George Busk, Esq., F.R.S., in the alimentary canal of a Lascar. The original description states that "these flukes were much thicker and larger than those of the sheep, being from an inch and a half to near three inches in length." One example may be seen in the Museum of the Royal College of Surgeons, Lincoln's Inn; and a second in the Museum of the Middlesex Hospital Medical College.

2. The *Distoma veliporum*, procured by Professor Otto, of Breslau, from the stomach of a large Mediterranean shark (*Squalus griseus*). This fluke acquires a length of fully three inches.

3. The *Fasciola gigantea*, a trematode of equal longitude, and rather broader than the last named. Forty specimens were found by the writer in the liver of a young giraffe, which died in Wombwell's travelling menagerie, at Edinburgh, during the severe winter of 1854-55.

4. The *Distoma gigas*, discovered and described by the

Italian naturalist Nardo. This is the longest fluke-worm known; it attains a length of no less than five inches, and has hitherto been found only within the stomach of a large fish (*Luvarus imperialis*), which frequents the Adriatic Gulf and the coasts of Sicily.

The ordinary aspect of these creatures is not such as would, at first sight, recommend itself to the attention of the general observer; yet those who will take the trouble to submit them to microscopic examination will find their senses gratified, not only by the evidence of a fair exterior, but by the exhibition of elegantly-grouped internal organs. If, further, a satisfactory attempt be made to inject some of the larger species, the beauty of the specimens will be thereby increased tenfold. To be completely successful, however, finely-pointed syringes must be employed, aided by the most careful and delicate manipulations. Up to the present time, indeed, we believe that the so-called vascular system of the trematoda has been efficiently injected only by M. Emile Blanchard, of Paris, and by the author of this communication.

The introduction of pigments not only renders the objects more attractive in appearance, but, at the same time, facilitates our comprehension of their anatomical peculiarities. In the illustrations, therefore, here or in future selected, to render this subject clear, we shall employ colouring as follows:—

*Blue* for the digestive system. Hitherto we have found artificially prepared ultramarine to answer the purpose admirably. Specimens of flukes from the giraffe, thus injected by the writer, may be seen in the Anatomical Museum of the University of Edinburgh, and in the author's private collection of Entozoa.

*Red* for the water-vascular system. The distinguished disciple of Baron Georges Cuvier, above-mentioned, has here employed vermilion, and we have adopted the same plan. The principal figures in the accompanying plates will be, in part, taken from the inimitable drawings of Blanchard, as given by him in Victor Masson's imperial-octavo edition of "Le Règne Animal," and in the eighth volume of the Zoological division of the third series of the "Annales des Sciences Naturelles." From the extreme beauty of the representations just referred to, some parasitologists have been led to question their accuracy. Recently, however, the writer had the satisfaction of convincing an eminent German naturalist that his surmises in this respect were fallacious; for, on exhibiting to him two similarly injected flukes from the author's own collection, he credited the French helminthologist with the highest manual skill, to which we believe him to be justly entitled.

*Yellow* for the reproductive system. This colour is usually

more or less present in the organs included under this group of structures, owing particularly to the presence of multitudes of minute eggs, whose shells are highly tinged. Two shades will be introduced; namely, *orange yellow* to characterize the female tissues, and *pale yellow* to represent those of the opposite sex.

Other pigments may be occasionally employed where the natural colouring of the skin, or other special circumstances, seem to render their exhibition suitable.

The fluke which we have first selected for description and illustration is the cone-shaped amphistome, or *Amphistoma conicum* of Rudolphi. This parasite is common in oxen, sheep, and deer, and it has also been found in the Dorcas antelope. This amphistome almost invariably takes up its abode in the first stomach, or rumen, attaching itself to the walls of the interior. In the full-grown state it never exceeds half an inch in length; but in the accompanying plate we have purposely given a large central figure (1), representing the fluke magnified ten diameters linear, whilst the upper figures (2 and 3) respectively afford an anterior and lateral view of the same individual. If closer inspection be made it will be seen that the animal is furnished with two pores or suckers, one at either extremity of the body, the lower being by far the larger of the two. By means of the latter the amphistome anchors itself to the papillated folds of the paunch, or first stomach, as this organ is improperly called.

In the central figure the following structures may be remarked. The oral sucker at the anterior end, or head, as it is termed, leads into a narrow tube forming the throat or œsophagus, and this speedily divides, or rather widens out, into a pair of capacious canals. These cavities are correctly regarded as together constituting the stomach; but they are cæcal, that is, closed below, having no other outlet than the entrance above mentioned. Hence we justly infer that nearly all the materials or juices received into the body of the fluke are in a fit state to be at once absorbed into the system; yet it is not at all improbable that indigestible particles are occasionally expelled from the mouth, when the cæca are over-distended by their accumulation. On examining flukes it is very common to observe this engorgement of the alimentary canals, and, taken in connection with other characters, it affords the parasitologist a ready mode of ascertaining to what *genus* the Entozoon belongs. In most flukes the digestive canal is thus simple and divided; but in Fascioles, as we shall subsequently illustrate when describing the common liver fluke, it is strikingly dendritic or regularly branched.

The water-vascular system next demands our attention.

The vessels thus named vary greatly in disposition, not only among the flukes, but also in other orders of parasites. This circumstance, along with other considerations, has given rise to much discussion as to their nature and function. Into the debate we do not now propose to enter, but may remark in passing, that there do not appear any very good grounds for considering them equivalent to the true blood-vessels of other invertebrated animals. In the present example, however, it will not be denied that the vascular arrangements bear a very striking resemblance to that of arteries or veins; and the centrally-placed pouch (as shown in Fig. 1 of the accompanying plate) might very easily be taken to represent the heart. This large cavity gives origin to two primary trunks, which pass forward along the inner sides of the digestive cæca; in their passage they send off secondary branches which divide and subdivide until we arrive at a series of minute capillary ramifications, the latter, according to Blanchard, terminating in small oval-shaped sacs or lacunæ. The last-named organs are placed immediately beneath the skin, and appear to have a special connection with that structure, the nature of which will be subsequently considered. Whatever may be the significance of these lacunæ—and on this point much might be said—all will agree that the arrangement of the vessels in connection with them is extremely beautiful. Hitherto no one has discovered any external outlet to the central pouch; yet, in all probability, such an opening exists. Several observers have considered this water-vascular system as directly connected with the organs of digestion; but, in maintaining this opinion, they are clearly erroneous.

In an anatomical and physiological point of view, the study of the reproductive system possesses high interest. Nearly all the flukes are hermaphroditic, that is to say, each individual is at one and the same time both male and female. In the large Figure (1) the essential organs connected with this system are only partially indicated. The central tortuous canal is the so-called uterus; this, as shown in the dissection below (Fig. 4), communicates with two rounded sacs, one in front of the other; in this situation it also subsequently divides into two tubular branches; these tubes pass right and left, one to either side of the body, and curving upwards, after the fashion displayed in the drawing, they branch out into exquisitely delicate ramifications which terminate in little grape-like bunches. In different kinds of flukes these botryoidal structures display a variety of appearance, and are collectively denominated the yelk-forming organs. The germs of the future eggs are developed in a separate glandular body called the ovary, which latter, in the present

XUM

species, is probably represented by the larger of the two vesicles seen at the junction of the lateral ducts leading from the branched organs above described. The smaller sac lying in front is, in all likelihood, an accessory pouch in which the germs become surrounded by the yelk-particles or granules; the essential act of fertilization is, likewise, herein effected at the same time, by the presence of Spermatozoa which have succeeded in gaining access to the pouch. After a while, the perfectly developed eggs descend into the broad uterine tube, and by their numerous presence impart a deep yellowish or orange-brown colour to this organ. The ova themselves are very small, the largest being about the $\frac{1}{150}$ of an inch long, and $\frac{1}{250}$ of an inch broad. The example here drawn (Fig. 6), was taken from an Amphistoma, which, with many others, the writer obtained from the paunch of a Zebu, formerly living in the Zoological Society's Gardens, Regent's Park. The illustrations on the opposite side of the plate represent the male reproductive elements, the lower one (Fig. 5) showing the two largely developed testes, which are irregularly divided into five or six lobes; the latter consisting of numerous smaller lobules. From each of these glands there passes off a duct or *vas deferens*, the two afterwards combining to form a single channel; this becomes enlarged towards the end, where it constitutes a sheath for the lodgment and protection of the intromittent organ. The small pencillings higher up (Fig. 7) represent the sperm-cells, containing extremely minute Spermatozoa. In the Amphistome, as in most flukes, the external reproductive orifices terminate separately, and near each other, at the anterior third of the body, their position being generally indicated by a smooth, oval-shaped, papillary eminence.

A nervous system has been described (by Laurer and Blanchard) in Amphistomes. It consists of two so-called cerebral ganglions representing the brain; and from each of these there passes off on either side a chain of smaller ganglia, all of which distribute nerve filaments to the skin. As similar arrangements obtain in other flukes, we shall only here further remark that no one has hitherto discovered any organs of special sense in the true Trematodes or Flukes.

It remains for us further to observe, that the surface of the Amphistome, though quite smooth to the naked eye, is clothed with a series of minute tubercles, which may be readily brought into view under a half-inch object-glass. Beneath the cuticle we find a layer of cellules forming the true skin; and beneath this, again, there are two, if not three, layers of muscular fibre; an anterior longitudinal series, and an inner circular set being readily distinguishable. The substance of the body is traversed by bands of cellular parenchyma or connective tissue, which

here and there form thickened sheaths for the support of the various delicate organs above described.

The larval condition of *Amphistoma conicum* is at present unknown, but in all probability it lives in or upon the body of snails. This we infer from the circumstance that the larvæ or *cercariæ* of a closely allied species—the *Amphistoma subclavatum*, which infests the alimentary canal of frogs and newts—have been found by Professor de Filippi of Turin, and by Dr. Pagenstecher of Heidelberg, on the surface of the body of various species of *Planorbis;* whilst Professor Van Beneden, of the Louvain University, has discovered the larvæ in various species of *Cyclas*.

There can be little doubt, therefore, that some of the water snails harbour the larvæ of *Amphistoma conicum;* and, as a natural consequence, when deer, sheep, or cattle resort to ponds or running streams for the purpose of quenching their thirst, they swallow, accidentally, as it were, the aforesaid pond-snails. The cercariæ, or larvæ, are thus transferred to the paunch, where, attaching themselves to the walls of the interior, they complete their final stage of development.

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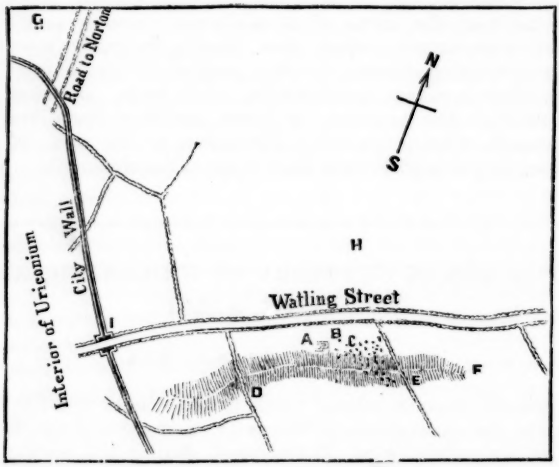
## THE ROMAN CEMETERY OF URICONIUM, AT WROXETER, SALOP.

BY THOMAS WRIGHT, M.A., F.S.A.

For several reasons, among which not the least was the want of funds, the excavations at Wroxeter on the site of the Roman city of Uriconium were discontinued during the spring and summer of the past year (1861), and further delay was caused in the autumn by the necessity of waiting until the crops had been cleared off from the ground. It had been determined to commence operations on this occasion upon the site of the principal cemetery of the Roman city, which lies at a considerable distance from the former excavations. At length, in the month of September, the ground was very liberally placed at the disposal of the Committee of Excavations by the tenant-farmer, Mr. George Juckes, of Beslow, and the men were employed in exploring this ground, by means of trenches, from the middle of that month to the end of November.

A slight plan of the ground will enable us best to explain the object and progress of these excavations. It may be premised that the invariable custom of the Romans forbade the burial of the dead within the limits of a town, for religious as

well as sanitary motives. This rule was strictly adhered to in all the Roman towns in Britain which have been to any degree explored. It was followed in Uriconium, where the principal cemetery lay outside the eastern gateway, bordering the road which led towards Londinium (London), and which is now called the Watling Street. In most of the Roman towns in this island, we find that the principal cemetery lay, like this, on the road leading to the chief town in the island; but we can point out another motive for selecting this locality at Uriconium, in the circumstance that it was the highest ground round the city, and the least exposed to be overflowed by the floods




SITE OF THE CEMETERY OF URICONIUM.

from the Severn. In our cut, the letter I marks the site of the eastern gate of the city of Uriconium, the dark line representing the line of the town wall. The Watling Street, as will be seen, runs from it in nearly an easterly direction. To the south the ground rises from the road in a gentle bank, the brow of which, in the field where the excavations have been chiefly carried on, is marked by the shading from D to E. Attention had been called to this locality by the accidental discovery, it is supposed not far from the spot marked E, of seven slabs of stone bearing interesting sepulchral inscriptions, which are still preserved in the Library of Shrewsbury School. This discovery furnished at least a very strong presumption that this

field formed part of the cemetery, and trenches have been carried from the hedge separating it from the Watling Street road over the whole extent of the bank, and further over the field to some distance to the south. One of the first discoveries, made at the spot marked B, low down on the slope of the bank, was a very important one—a thick slab of stone was found lying on its face, on which, when raised, a rather long and very well incized inscription was found, probably as early as the second century, commemorating a soldier, whose name appears to have been FLAMINIVS. T. POL. F. (the latter letter, of course, standing for *filius*), who was forty-five years of age, and had seen twenty-two years of military service. Unfortunately, the inscribed side of the stone has been much rubbed, and the inscription has not yet been completely deciphered. Further exploration showed that the whole of this end of the bank was filled with interments, consisting of cinerary urns and their usual accompaniments, which appeared to have been put into the ground in rows. These interments covered the ground marked in our plan with dots. Trenches, carried further towards the ancient town wall, or beyond the bank across the field, gave no traces of burials, so that this appears to have been the extremity of the burial-ground towards the town. The cemetery probably extended over the next field F, which cannot conveniently be excavated until the autumn of the present year. The excavators have since been employed in the field H, on the other side of the Watling Street, in the farm of Mr. Bayley, of Norton, but no discoveries of sepulchral interments were found there, and the cemetery would thus appear to have been confined to the southern side of the road. An accidental discovery, however, led to the examination of a garden in the hamlet of Norton, at G in our plan, and there was found one well-defined interment, besides traces of others. It is not improbable, therefore, that the tombs of the citizens were scattered over the ground outside the walls along the greater part of their extent. We have not only by these excavations ascertained the site of what was evidently the principal cemetery of Uriconium, but we have obtained a number of objects and ascertained a number of facts, which illustrate the manners of the inhabitants of Uriconium, and show us how entirely conformable they were to those of the Romans in their native Italy.

When we use the word *cemetery*, we do not of course intend it to be taken strictly in its modern sense, but merely to signify the locality where the sepulchral interments were collected together. The Romans did not inclose and consecrate a space of ground for burial purposes as we do in modern times, but the family of the deceased bought a bit of ground to bury

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him wherever they could obtain it to their own satisfaction, provided it was not within the walls of a town. The possessor of a villa in the country appears to have had his burial-place within the precincts of his own house, as was the case in the Roman villa recently uncovered at North Wraxhall, Wilts, by Mr. Poulett Scrope, and described in the Wiltshire *Archæological and Natural History Magazine* for October, 1860; and in that at Walesby, in Lincolnshire, described in the *Reliquary* for October, 1861. The inhabitant of a town, as we have just stated, bought himself a piece of ground outside the town; and from the circumstance of its being the repository of the dead, it became consecrated, and to trespass upon it was regarded as sacrilege. Nevertheless, the ground adjoining might be employed for any other purpose; and suburban houses and villas might be intermixed with the tombs, as was the case in Pompeii. In fact, the Roman seems, even when dead, to have still courted the proximity of the living, for he always by preference sought to establish his last home as near as possible to the most frequented road; and the inscriptions on his roadside tomb often contained appeals to the passers-by—in terms such as SISTE VIATOR (*stay, traveller*), or TV QVISQVIS ES QVI TRANSIS (*whoever thou art, passenger*)—to think on the departed. The epitaph on a Roman named Lollius, published by Grüter, concludes with the following words, intimating that he was placed by the roadside, in order that the passers-by might say, "Farewell, Lollius!"

HIC . PROPTER . VIAM . POSITVS
VT . DICANT . PRAETEREVNTES
LOLLI . VALE.

These examples will explain the position of the cemetery of Uriconium, and of those of the other Roman towns in Britain.

To explain the various objects which have been found in our excavations, it will be necessary to give a brief sketch of the formalities which attended death and burial among the Romans. The last duty to the dying man was to close his eyes, which was usually performed by his children, or by his nearest relatives, who, after he had breathed his last, caused his body first to be washed with warm water, and afterwards to be anointed. Those who performed this last-mentioned office were called *pollinctores*. The corpse was afterwards dressed, and placed on a litter in the hall with its feet to the entrance door, where it was to remain seven days. This ceremony was termed *collocatio*, and the object of it is said to have been to show that the deceased had died a natural death, and that he had not been murdered. In accordance with the popular superstition, a small piece of money was placed in the mouth,

which it was supposed would be required to pay the boatman Charon for the passage over the river Styx. In the case of persons of substance, incense was burnt in the hall, which was often decked with branches of cypress, and a keeper was appointed, who did not quit the body until the funeral was completed. The public having been invited by proclamation to attend the funeral, the body was carried out on the seventh day, and borne in procession, attended by the relatives, friends, and whoever chose to attend, accompanied by musicians, and sometimes with dancers, mountebanks, and performers of various descriptions. With rich people, the images of their ancestors were carried in the procession, which always passed through the Forum on its way to the place of burial, and sometimes a friend mounted the rostrum and pronounced a funeral oration. In earlier times the burial always took place by night, and was attended with persons carrying lamps or torches, but this practice seems to have been afterwards neglected; yet the lamps still continued to be carried in the procession. Women, who were called *præficæ*, were employed not only to howl their lamentations over the deceased, and chant his praises, like the Irish keeners, but to cry also; and their tears, it appears, were collected into small vessels of glass, and this circumstance is termed, in some of the inscriptions found on the Continent, being "buried with tears,"—*sepultus cum lacrymis*,—and the tomb is spoken of as being "full of tears."—TVMVL . LACRIM . PLEN.

The next ceremony was that of burning the body. In the earlier ages of their history the Romans are said to have buried the bodies of their dead entire, without burning; and there seems to be no doubt that, at all events, the two practices, burning the body and cremation, existed at the same time, but the latter appears to have become gradually more fashionable, until few but paupers were buried otherwise. In the age of the Antonines the practice of cremation was finally abolished in Italy, but the imperial ordinances appear to have had but little effect in the distant provinces, where the two manners of burial continued to exist simultaneously. Both are accordingly found in the Roman cemeteries in Britain, in interments which were undoubtedly not those of Christians. Perhaps the practices varied in different parts of the island, according to the usages of the country from which the colonists derived their origin. It is a circumstance worthy of remark that, as far as discoveries yet go, no trace has been met with of burials in the Roman cemeteries of Uriconium, otherwise than by burning the dead.

The funeral pile, *pyra*, was built of the most inflammable woods, to which pitch was added, and other things, which often rendered this part of the ceremony very expensive. An in-

scription, preserved by Grüter, speaks of some persons whose property was only sufficient to pay for the funeral pile and the pitch to burn their bodies—*nec ex eorum bonis plus inventum est quam quod sufficeret ad emendam pyram et picem quibus corpora cremarentur.* It had been ordered by a law of the Twelve Tables, that the funeral pile must be formed of timber which was rough, and untouched by the axe, but this rule was perhaps not very closely adhered to in later times. When the body was laid on the pile, the latter was sprinkled with wine and other liquors, and incense and various unguents and odoriferous spices were thrown upon it. It was now, according to some accounts, that the *naulum*, or the coin for the payment of the passage over the Styx, was placed in the mouth of the corpse, and at the same time the eyes were opened. Fire was applied to the pile by the nearest relatives of the deceased, who, in doing this, turned their faces from it while it was burning; the relatives and friends often threw into the fire various objects such, as personal ornaments, and even favourite animals and birds. When the whole was reduced to ashes, these were sprinkled with wine (and sometimes with milk), accompanied with an invocation to the *manes*, or spirit of the deceased. The reader will call to mind the lines of Virgil (Æn. di. 226):—

> Postquam collapsi cineres, et flamma quievit,
> Relliquias vino et bibulam lavere favillam,
> Ossaque lecta cado texit Corynæus aëno.

The next proceeding, indeed, was to collect what remained of the bones from the ashes, which was the duty of the mother of the deceased, or, if the parents were not living, of the children, and was followed by a new offering of tears. Some of the old writers speak of the difficulty of separating the remains of the burnt bones from the wood ashes, and we accordingly find them usually mixed together. When collected, the bones were deposited in an urn, which was made of various materials. The urn, in Virgil, was made of brass, or perhaps bronze. Instances are mentioned of silver, and even gold, being used for this purpose, as well as of marble, and those found in Britain are often of glass; but the more common material was earthenware. One of the performers in the ceremony, whose duty this was, then purified the attendants by sprinkling them thrice with water, with an olive branch (if that could be obtained), and the *præficæ* pronounced the word *Ilicet* (said to be a contraction of *Ire licet*, you may go). Those who had attended the funeral, thrice addressed the word *Vale* (farewell) to the manes of the dead, and departed. A sumptuous supper was usually given after the funeral to the relatives and friends.

In the case of people of better rank, the body was burnt on the ground which had been purchased for the sepulchre, but for the poorer people there was a public burning-place, which was called the *ustrina*, where the process was probably much less expensive, and whence the urn, with the remains (*relliquiæ*) of the deceased, was carried to be interred. The tombs of rich families were often large and even splendid edifices, with rooms inside, in the walls of which were small recesses, where the urns were placed. None of the buildings remain at Wroxeter, or, indeed, in any Roman cemetery in our island, but we can hardly doubt that such tombs did exist in the cemetery of Uriconium, and that they were scattered along the side of the Watling Street. At the spot marked A on our plan, the foundations of a small building were met with, which appeared to have consisted of an oblong square, with a rectangular recess behind, but the western portion of it has been destroyed by the process of draining. When opened, ashes and fragments of an urn were found in the inclosed space, so that it is not improbable that this may have been a tomb with a room. The inscribed stone already mentioned, which was found not far from this spot, bears evidence, in the appearance of its reverse side and in its form, of having been fixed against a wall, probably over a door; and the other inscribed stones, found in the last century, had probably been placed in similar positions. The urn was perhaps here interred beneath the floor of the room.

In more than one case in the cemetery of Uriconium, the dead body was certainly burnt on the spot where it was to be buried. At the spot marked C in our plan, we found undoubted evidence of cremation in the grave. A square pit had been dug, on the floor of which the funeral pile had been laid. My friend, Mr. Samuel Wood, of Shrewsbury, who was present when this pit was opened, remarked that the remains of the timber of the funeral pile still remained as it had sunk on the floor, the ends of which were unconsumed, and the earth underneath quite red from burning. Mr. Wood gathered up some fragments of melted glass among the ashes, the remains of some of the small vessels containing aromatics or unguents, which were thrown into the fire; and, he adds, in a letter on the subject, written at the time of the discovery, "One curious point I noticed, that you could positively tell from which direction the wind was blowing at the time of combustion, as one side of the hole was quite burnt and all the wood; whereas on the opposite side, the ends of the fuel were there, with the one end only charred. The wind was in the west, or W.S.W. This, of course, is quite unimportant; but one might venture a guess that it occurred in autumn, when the prevailing wind is from

the west, or south-west." At the spot marked G in our plan, where considerable traces of Roman sepulchral interments were found in the garden of a cottage occupied by Miss Bythell, a similar pit was found, with this difference in its circumstances: in the former case, the soil into which the pit was cut is a clayey loam, which would itself form a tolerably firm wall; but the soil on the site of Miss Bythell's garden was a light and sharp sand, which would crumble in unless supported. In this case, therefore, the pit, which was somewhat more than six feet square, was lined with clay, both bottom and sides, to a thickness of twelve or fourteen inches; and the heat of the fire had been so great, that the clay was baked quite through; and even the sand beyond it, in its changed colour and appearance, showed evident marks of the action of fire. Mr. Wood, who was also present immediately after this grave was opened, described it as having somewhat the appearance of a large square baked vessel. The remains of the corpse had been collected, and deposited in a very large urn, which was placed upon some flat tiles, and supported and surrounded with clay and broken flue-tiles. Under it was found a coin of the emperor Trajan, of the description termed by numismatists second brass.

In most of the other cases of interment yet discovered in the cemetery of Uriconium, a small hole or pit appears to have been sunk in the ground, and the urn, which had no doubt been brought from the *ustrina*, was placed in it and covered up. These interments were not far distant from each other, and, as I have already remarked, appear to have been placed in rows, nearly parallel to the road. Perhaps the ground may have been bought for this purpose in common, by associations of the townsmen—such as trade corporations; or it may have been set aside for burial purposes by the municipal authorities, and sold in small portions to individuals, as the practice now exists in modern cemeteries. It may be remarked that the accumulation of soil above the Roman level is here very much less than in the interior of the ancient city, where we have to dig frequently from ten to twelve feet to reach it. The top of the clay walls of the pit in Miss Bythell's garden was from fourteen to sixteen inches below the present surface; and the inscribed slab, commemorative of Flaminius Titus, which was found lying on its face, probably on the original level of the ground, or very near it, was met with at about eighteen inches below the present surface. We may, therefore, probably reckon the accumulation of earth on the side of the cemetery at from eighteen inches to two feet. The average depth at which the urns have been found is somewhat less than four feet, so that the Romans seem to have dug pits about two feet deep for their reception.

These recent excavations in the cemetery have contributed

SEPULCHRAL URNS FROM THE ROMAN CEMETERY OF URICONIUM. (*Scale* 2 *inches to a foot.*)

a considerable number of urns, many of them perfect, and others so broken only as to be easily put together, to the Wroxeter Museum, in Shrewsbury. A few examples, with some of the jug-shaped vessels also found in the graves, are given in the accompanying cut. The urns, which are of baked earthenware, of different shades of colour, but mostly brown or red, are of coarse substance, but always more or less well-shaped, and vary very much in size. The largest we have yet found is about eighteen inches high. The jug-shaped earthen vessels were perhaps used to contain some liquids which were interred with the remains of the dead; but when found they were filled with earth. Our next cut represents a group of glass vessels and other objects found in the cemetery of Uriconium. We know, from allusions in some of the ancient writers, as well as from inscriptions, that tears, unguents, and aromatics, were sometimes thrown on the funeral pile, and sometimes interred with the dead—contained, as it may be supposed, in small vessels of glass. An inscription in Grüter describes the deceased as being "moistened with tears and balsam"—EVM . LACHRIMIS . ET . OPOBALSAMO . VDVM. The reader will call to mind, also, the lines of Tibullus (Eleg. lib. iii.; El. ii. l. 19), in which he speaks of depositing with the dead the precious products of Arabia and Assyria, as well as the tears of relations and friends:—

"Et primum annoso spargant collecta Lyæo,
Mox etiam niveo fundere lacte parent.
Post hæc carbaseis humorem tollere ventis,
Atque in marmorea ponere sicca domo.
Illic quas mittit dives Panchaia merces,
Eoique Arabes, dives et Assyria.
Et nostri memores lacrimæ fundantur eodem.
Sic ego componi versus in ossa velim."

These precious objects were probably contained in the small narrow glass phials which are so commonly found in the Roman graves, and which, in the belief that they contained only the tears of the mourners, antiquaries have designated by the name of lachrymatories. Some experiments, made by my friend Dr. Henry Johnson, of Shrewsbury, upon the earth contained in these glass vessels, seem to confirm the belief that they were not merely receptacles of tears. He writes to me on the 11th of November: "Respecting the lachrymatories, I have lately seen rather a confirmation of what you said about these having been filled with unguents, incense, or something of that kind, which would by heat yield much carbon or charcoal. I took two of these little glass vessels which had dark matter in them, and which had never been emptied. I put some of the dark matter under the microscope, and I could see pure red grains

ROMAN GLASS VESSELS AND POTTERY FROM THE CEMETERY OF URICONIUM. (*Scale* 3 *inches to a foot*)

of the sand of the field,* and intermixed with these many visible particles of pure black carbon, evidently introduced artificially into the sand. On putting some of the soil in a platinum crucible, and heating it red-hot for a few minutes, *all* the charcoal was burned away, and I got a pure red sand like that of the cemetery. The contents of these two vessels were quite black, though I have no doubt they were found deeper than the superficial covering of black mould. One of them had evidently been subjected to fire, so that the supposition that this had been filled with some unctuous oblation, and then acted upon by heat in the funeral pile, is not at all improbable."

These glass vessels help to demonstrate that the same forms were observed by the Romans in their performance of the sepulchral rites in Britain as in Italy. Some of them are found greatly affected by fire, and have been no doubt placed on the funeral pile; others, on the contrary, are perfect, and have evidently never been in the fire, but were no doubt deposited with the urn. Examples of them, in both conditions, are given in our last wood-cut. The one in the middle of the three to the right has been thus affected by the heat in a lesser degree; but the other, lying on the ground beneath it, has been so much melted as to have lost its original shape.

A very usual accompaniment of Roman interments is the lamp, usually made of terra-cotta. There can be no doubt that, under the influence of sentiments with which we are not well acquainted, lamps were among the usual offerings to the dead, and that, when offered, they were filled with oil and lighted. They were found in the tombs at Pompeii, where they were probably placed in the recesses of the walls by the side of the urns of the dead. Their frequent occurrence under such circumstances gave rise to a number of old legends of the finding of lamps still burning in tombs of the ancients, who, it was supposed, had invented a material for the lamp which, once lighted, would burn for ever. One epitaph, found at Salernum, and given in Grüter, which commemorates a lady named Septima, expresses, in what appears to have been intended for elegiac verse, the wish that whoever contributed a burning lamp to her tomb, might have a "golden soil" to cover his ashes.

HAVE . SEPTIMA . SIT . TIBI
TERRA . LEVIS . QVISQ
HVIC . TVMVLO . POSVIT
ARDENTEM . LVCERNAM
ILLIVS . CINERES . AVREA
TERRA . TEGAT

* To explain this, it must be stated that the soil of the field, which is hardly two feet deep, lies upon a deep bed of pure sand, and that the interments had all been made in the sand in which the urns and other objects were found.

It is probable that the lamp was burning when it was placed in the grave with the urn. Two lamps only have been found in our excavations in the cemetery of Uriconium, which are represented in our last cut, and are of the same form which the Roman terra-cotta lamp almost invariably presents. In one of them the field is plain; in the other it is adorned with the figure of a dolphin.

The same scarcity which thus characterizes the lamps, is also to be remarked in the Roman coins, of which only one has yet been met with in the cemetery by the Watling Street, a second brass of the Emperor Claudius; and two in Miss Bythell's garden, one of Trajan, the other of Hadrian. The coin of Trajan was found under the urn, and must therefore have belonged to the interment; and, as it bears distinct marks of having been exposed to the flames, it has evidently been burnt with the corpse. The early date of these coins is worthy of remark, and though it does not necessarily prove the early date of the interment, it may perhaps assist in explaining their rarity. However large may have been the amount of true Roman and Italian blood among the founders of the town, the number of the inhabitants was no doubt kept up and probably increased in after times by recruits from other countries, perhaps much of it German; and these strangers to Roman feelings, when they accepted Roman manners and customs, may have neglected many of the minor details. Perhaps they were not convinced of the necessity of exporting the current coin of the state, in however small quantities, to the infernal regions, and they may have deliberately retained Charon's passage-fare. They may also have discontinued the practice of placing lamps in the grave, or it may only have been observed occasionally. It must at the same time be remarked, that single coins are the objects of all others most likely to escape the notice of the excavators.

Nearly all the graves, however, appeared to have contained the urns and the small glass phials; and in some there were other vessels of glass and earthenware, and among the latter some good examples of the well-known Samian ware. The vessel in the middle of our last cut is a large and remarkably handsome glass bowl, which was found among the graves on the side of the bank. Behind it is a flat dish of the light red ware, which is found rather plentiful among the Roman ruins at Wroxeter, and appears to have been manufactured in the district. The fractured vessel, to the right of it, has been a very handsome bowl of Samian ware. The vessel to the extreme left is a much more uncommon ware, of a lemon-yellow drab colour, and ornamented with rows of small knobs. All these vessels have no doubt contained the offerings of the living to the *manes* of the dead.

It may be remarked, in conclusion, that the comparatively slow accumulation of earth on the site of the cemetery explains easily the almost total disappearance of its monuments which stood above-ground. We learn from early writers, such as the historian Bede, that people went to the cemeteries of the Roman towns to seek for materials long before they began to break up the towns themselves, and as these materials must have lain for ages visible on the surface of the ground, and at the same time consisted probably of large and useful stones, they held out a stronger temptation to such depredators. Fortunately, the stones most likely to escape were those which contained inscriptions, because the people who had succeeded the Romans entertained a dread of all inscriptions which they could not read, believing them to be dangerous magical charms. Hence we find, here and there, an inscribed stone lying where it was dropped or thrown, when every other fragment of the monument to which it belonged has disappeared.

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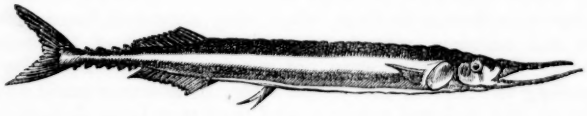


## THE SKIPPER, SKOPSTER, OR SAURY.

BY JONATHAN COUCH, F.L.S.

LINNÆUS expressed the wonder he felt that animals could be created with such properties as to be able to pass their lives beneath the waves; but we, on the other hand, may express our wonder that creatures whose proper residence is in the waters should be able to raise themselves high above it, and thus imitate the birds in sailing through the air. Yet who has not heard of the flying-fishes? and what landsman, and woman too, has not wished that at least for a little space they could be transported to the scenes where such amusing sights are met with, and view, without the inconvenience of a voyage, the flight of these little creatures as they spring up in haste to escape the hurried chase of enemies below? But scenes like these may be witnessed without encountering the sea-sickness and dangers of the sea; and we possess among ourselves, for a portion of the year, a fish which, strange to say, is able to

imitate the actions of the flying-fish, although not endowed like it with wing-like fins. In the summer and autumn this faculty is not unfrequently called into action, and in doing this it finds even a more certain safety than is the lot of the fish which is usually called by that name; for while the latter in its blind haste often falls into an equal amount of danger from that which it sought to escape, by dropping on the deck of a ship, we have never known the other to encounter a like misfortune. But it is time we should more particularly mention the name of the fish to which our remarks apply; this species, then, is the *Esox saurus* of Linnæus, and *Scomberesox saurus* of Cuvier; of which a larger representation, in its natural colours, will be given in the "Natural History of Fishes of the British Islands," now in the course of publication.

By the unlearned fishermen of the West of England, the name bestowed on this fish is the Skipper, or more broadly the Skopster, and by some observers it is called the Sea-mouse, on account of a motion it sometimes adopts; perhaps when not very closely pressed by a pursuer, or it may be, even in sport, for the most timid fishes have their sports, more even than their voracious pursuers, and very amusing sports they often are. On these occasions first one of these fishes darts above the surface of the deep, which at that time is perhaps as calm and smooth as a mill-pond. It appears to run along upon the surface without for a moment dipping beneath, but barely touching the water with the points of its pectoral and ventral fins; the action appearing as if it bounded along like a mouse as it quickly passes from one hole to another. But in its onward course this individual is not long alone, and in a few seconds a whole bevy of these fishes are engaged in the race, until, perhaps tired with the exertion, they sink below and all is over. On other occasions the true flying-fish is more closely imitated, and the action of flight is plainly accomplished by a single vigorous spring, in which the tail and finlets are the moving power, and by which they are carried aloft for the distance of thirty or forty feet, when they sink again in a sloping direction—it is to be feared, into the mouth of some voracious enemy that has watched their motions from below. In the flying-fish it is the pectoral fins which form the buoyant instrument of flight; but these in the skopster are of small size, and it is to their construction and manner of attachment to the body that they become fitted to the habits of the fish; their shape being so curved that it requires little effort to enable them to rise from their usual depth to the surface—as the wings of the lark enable it to rise and hover, in a manner, beyond the capacity of most other tenants of the air; and when the fish has reached the surface, the vigorous action of the tail and the small fins

near it are sufficient to give an impulse which insures what follows.

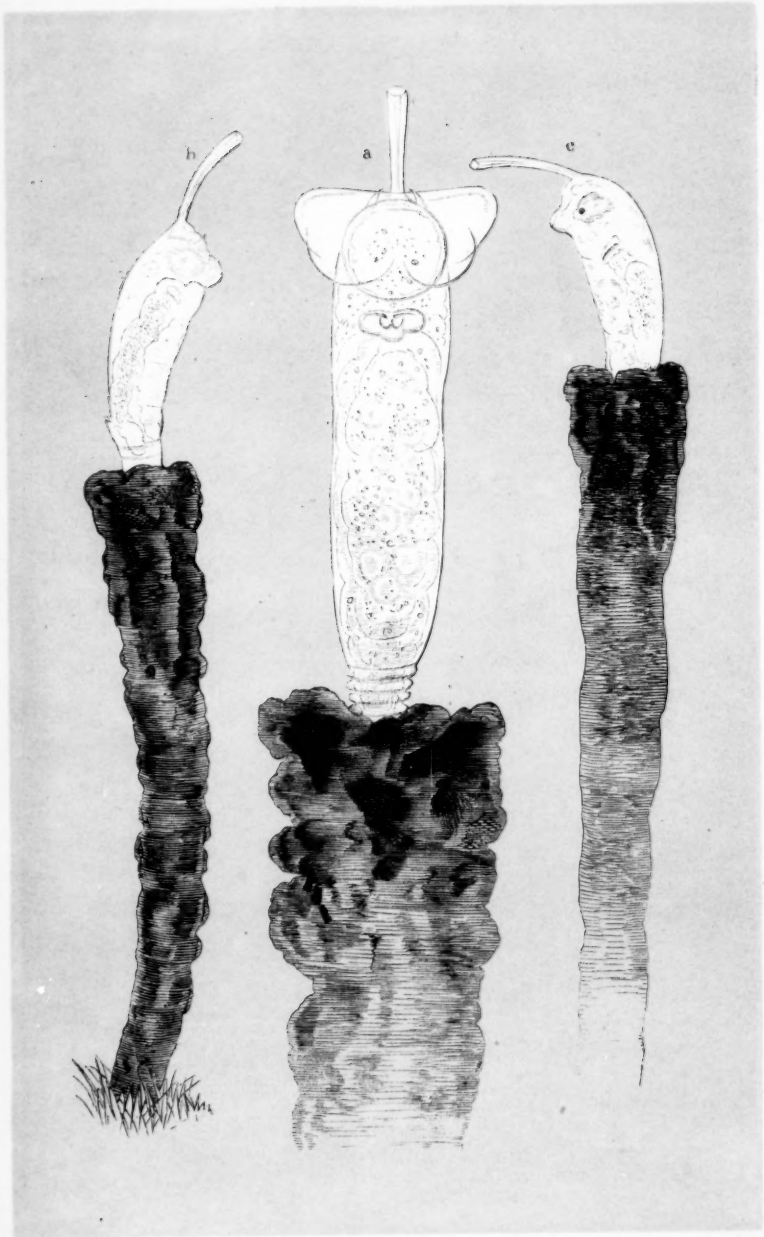
To witness these actions in perfection, the observer on land would do well to be possessed of a good glass of the binocular kind, and to station himself, at no great height, on some projecting portion of the western coast of the kingdom, in the summer or autumn. But there must also be called into action not only some degree of good fortune, but no slight stock of that commendable virtue patience, for this is not an exhibition that can be got up at our own pleasure; and even when it does occur, the gratification may receive some alloy in the reflection that, however agreeable to the observer, it is death to some of the performers.

This fish comes to our coast at about the end of May, and retires towards the close of autumn; and it usually swims at a slight depth from the surface, so that when nets are employed within a fathom or two of that range, many are caught, but when deeper they do not become entangled.

It is the opinion of fishermen that there exists some antipathy between this fish and some others of the gregarious sorts; in proof of which they allege that when the skippers have entered a bay in which there are what are technically called schools of pilchards—as they sometimes do in large multitudes—in a short time the pilchards leave the district: a circumstance which excites their notice, as being attended with a disappointment of their hopes.

The skipper has not been known to take the hook, which is to be ascribed perhaps to the form of its mouth, as well as to the want of an appropriate bait, rather than to indifference for food; which, on examination of the stomach, appears to consist of a great variety of materials. Sometimes, perhaps most frequently, it is formed of entomostraca, or those very small crustaceous animals which exist in myriads in the sea at almost all seasons. But I have also found pieces of red sea-weeds, and square pieces of the marine vegetable *Zostera marina*, with small stones; and as the zostera is not known to grow anywhere but in harbours where fresh water mingles with the salt, it is clear that such situations must sometimes be visited by these fishes. And that they do so is further shown by the fact, that in one instance an example of the fish was brought to me for examination that had been taken in a net, a few miles up a river, where it is only on rare occasions that the tide has been known to come.

The structure of the upper jaw is well fitted to retain any small but perhaps active prey it may chance to lay hold of, preparatory to its being swallowed; an operation which we may suppose not to be accomplished in an instant. On close ex-




P.H.Gosse del.

Cephalosiphon limnias.

amination it will be seen that along the slender maxillary projection there exists on each side a row of minute teeth which, on a small scale, bear no distant resemblance to the lateral teeth on the snout of the saw-fish, and which are very thickly projecting along the border on each side, with their points directed a little downward.

The ordinary length of this fish is about a foot, but not unfrequently it is seen a few inches longer; the shape inclined to round near the head, more compressed along the body, and tapering towards the tail. The head flattened above, the jaws protruded, the lower jaw longest, upper jaw the most slender. Scales rather large, but easily lost; and then the general colour becomes green where in the perfect state it is a light blue. Lateral line obscure; the belly with a low ridge along each side. Eye lateral, conspicuous; nostril in front of it open. The pectoral fin is broad at the base, pointed above; dorsal and anal fins far behind, nearly opposite, and close behind them five finlets above and the same number below; but I have seen six and even seven finlets above and below. Central fins small; tail forked. There is a row of minute blue dots along the border of the first gill-cover, seventeen in number, which appear to be the orifices of mucous-glands.

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## A ROTIFER NEW TO BRITAIN—(CEPHALOSIPHON LIMNIAS).

BY PHILIP HENRY GOSSE, F.R.S.

In the admirable new edition of Pritchard's "Infusoria" (p. 670), Professor Williamson has included in the family *Floscularicæa*, between the genera *Limnias* and *Lacinularia*, a genus named *Cephalosiphon*, with the following brief characters:—"Rotary organ bilobed; eyes two; sheath single; two frontal horns, including the siphon." One sole species is mentioned, thus characterized:—"*C. limnias*. Sheath membranous, annulate, 1—6‴ to 1—5‴. On *Ceratophyllum*. Berlin, July."

As no references are given to any authority, I wrote to Professor Williamson for further information, suggesting that for "including," we should probably read "inclosing." I was favoured with the following note in reply:—

"I am afraid I can give you no information respecting it. I found it in the last edition of 'Pritchard,' and from the habitat (Berlin) I concluded that it had been one of those genera established by Ehrenberg, which he has scattered broadcast through half the journals of Germany. Hence I did not feel at liberty to omit it,

though I could not trace its history. 'Including' should certainly have been 'inclosing,' as you suggest."

In Mr. Slack's "Marvels of Pond Life," p. 149, he has described and figured a tubicolous Rotifer, with a very long antennal process. He considered it to be *Limnias ceratophylli*, but noticed the discrepancy between the form of the trochal disk in my figure of that species in "Evenings at the Microscope," and that of his animal. Having intimated to this gentleman my suspicions that the creature was neither *Limnias*, nor any other with which I was acquainted, he was so kind as to send me from time to time a number of specimens, all found in considerable abundance studding the stems and leaves of *Anacharis alsinastrum*—a pond-weed which, Mr. Slack tells me, is fast displacing all other sub-aquatic vegetation in the waters about the north of London. The examination of the specimens thus transmitted, has confirmed the suspicion of its novelty to us, and has convinced me of its identity with the Berlin genus *Cephalosiphon*, and probably with the species *C. limnias*. This identification I shall, at least for the present, assume.

The animal manifests a very close affinity with *Œcistes*, *Limnias*, and *Melicerta*; in the form of its petaloid disk coming between the last-named two; for the outline of this organ (see Fig. A) may be described as two-lobed, with each of the lateral lobes having a tendency to divide into two; the entire form having a striking resemblance to the expanded wings of a butterfly, such as our little Orange-tip, for example. In the antenna, distinctness from each of the genera named is manifested, for while *Melicerta* has two rather long antennæ, *Limnias* two reduced to mere bristles, and *Œcistes* none at all, our *Cephalosiphon* displays a single one, of extraordinary length and versatile power. Like *Melicerta* and *Limnias* it shows no visible constriction or neck below the disk, whereas in *Œcistes* this is a conspicuous feature.

The animal inhabits a case slightly trumpet-shaped, generally of great length and slenderness, compared with those of its allies, standing erect on the pond-weed. It is irregular and floccose in outline, very opaque, and of a deep bistre or umber brown by transmitted light, but of a much lighter hue, cedar-brown, by reflected light. It is composed doubtless of an excretion from the skin as the foundation layer, thickened and opacified by the addition of the dark material, which I conjecture to be the fæcal pellets successively discharged in process of growth. Yet I must confess I have never seen the stomach or intestine charged with dark brown food, in any of those that I have examined, which have certainly been but few, in a healthy active condition.

Contrary to the rule in the allied genera, the petaloid disk

is made to open, by the bending forward of the head towards the ventral aspect, and its widest margin is the dorsal one. This is shown by the position of the cloacal orifice with respect to the foot, as seen in Fig. 6. Immediately behind the disk are two minute lateral horn-like points, which project from the head, and curve towards each other. These are sometimes visible both in a frontal and a lateral view, and with the disk closed or open (see Figs. A and B), but at other times the closest scrutiny fails in discerning them (Fig. C). Behind these, in the median line, there is an organ which is never concealed: it is the single antenna, which stands up perpendicularly from the occiput to a great height (being almost half as long as the body, exclusive of the foot), and generally arches over the front; but is capable of vigorous and sudden movements to and fro, and from side to side. It is evidently tubular throughout; either a simple tube with thick walls; or else, if the walls are thin, furnished with a slender piston which runs through its length. By analogy, this organ ought to carry a pencil of diverging bristles at its extremity; and Mr. Slack has so figured it; and has, moreover, mentioned in a private letter to me that he has again detected these hairs of unwonted length. On the other hand, I have utterly failed to detect the slightest trace of hairs or of ciliary motion in the antenna of one which I watched most carefully with powers of 600 and 800 diameters, aided by an achromatic condenser; though the animal was in vigorous condition, and threw about its tube most waywardly. I did detect signs of what seemed to be both inspiration and expiration through the tube; for an atom of extraneous substance that by accident was adhering to the tip, was now and then suddenly drawn into the open mouth of the tube, and presently as suddenly blown out. The appearance certainly favoured Ehrenberg's notion of this organ being a *respiratory* tube.

The disk when withdrawn forms a sort of pimple or mammillary prominence, with a pursed aperture, seated on the front of the head. In this condition, and with this exception, the general form of the trunk is cylindrical, with a slight swell on the dorsal aspect, and with the upper end rounded to the base of the antenna, and the lower to a closely and strongly wrinkled foot (Fig. A), of which, however, I have been able to see only the extreme upper portion, at a moment of unwonted extension. If, as is no doubt the fact, the lower extremity of the animal was in contact with the surface on which the case was erected, the foot must be capable of being drawn out to amazing length. I do not doubt that such was the fact; yet the upper portion of the animal is certainly able to shift its aspect in the case, and that with a measure of persistency which appears rather to indicate a voluntary change in the foot-hold than a mere twist.

The specimens that I have seen were remarkably translucent and free from colour; but the outlines of the internal organs are so evanescent as to be difficult of determination. The digestive system shows a *mastax*, of the form of that seen in *Limnias*, which I have represented in "Phil. Trans." 1856, pl. xviii. figs. 66—71. From this a short œsophagus leads to a wide and long stomach, extending down the dorsal half of the body-cavity, and merging by a constriction into a short intestine, whence a slender rectum turns abruptly upward, and opens by a cloaca seated between prominent points, capable no doubt of a very great protrusion at the moment of evacuation. As I have before observed, I have not in any instance seen the alimentary canal occupied by food; in each case, the stomach and intestine were transparent, save for some minute oil-bubbles and pellucid specks, and were tinged with a pale yellow hue, probably owing to effusion from the surrounding biliary glands.

The whole ventral half of the cavity is filled by an almost commensurate ovary, which in these specimens contained only undeveloped ova, in their usual form of clear, highly refractile spherieles, each with a dim nucleus.

The nervous system shows a comparatively large brain, seated as a defined gray cloudy mass of irregularly lobed form, immediately below the antenna, and behind the discal mammilla (Fig. c). The structure that permeates the antenna, whether tube or nervous thread, expands upon, and is lost in, this brain-mass; and on its side I saw, with great distinctness, in one specimen, a bright crimson eye-speck. I could not, by focussing, get a glimpse of the eye on the opposite side, perhaps from the opacity or the unequal refrangibility of the intervening tissues; but the position of this one implied that it was one of a pair. In no other specimen could I find a trace of eyes.

I have not been able to see any muscular bands or threads.

The *Cephalosiphon* is very lively and active in its motions. It is very ready to protrude from its case; and not at all prone to retire upon ordinary alarms, such as a jar upon the instrument, that would send the *Floscularia* or the *Stephanoceros* into its retreat in an instant. It is very curious to see it protruding; the long antenna is first thrust out, and jerked to and fro, as a feeler, exploring the surrounding water for safety. This being assured, a considerable portion of the body projects, with a quick jerk, which then, by its bowings and turnings, seems to aid the antenna in its investigations; presently, a good piece more of the body comes out, until at last we see the commencement of the wrinkled foot itself; the jerking and feeling still going on. Perhaps I have not been fortunate in my specimens; but I have not witnessed the opening of the disk in any instance; and the animal appears chary of exposing its facial

charms. Indeed, my delineation of the form of the disk rests on a single individual, so that I do not attach the same certainty to it as to other features which I have observed; and the more, as I could not trace the marginal cilia at work. Moreover, Mr. Slack has figured it of a very different shape.

The entire height of an average specimen in its ordinary state of extension is $\frac{1}{3\,3}$ of an inch; of which the foot is $\frac{1}{3\,0}$th, the body (from the cloaca to the base of the antenna), $\frac{1}{2\,0\,0}$th, and the antenna $\frac{1}{4\,0\,0}$th of an inch. The case generally reaches up to the cloaca. The greatest breadth of the body may be about $\frac{1}{7\,0\,0}$th.

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## NOTES ON THE PRECEDING PAPER.

BY HENRY JAMES SLACK, F.G.S.

Mr. Gosse, in transmitting the observations in the preceding paper, invited me to add any remarks, especially upon the great discrepancy between his sketch and that which I published in the "Marvels of Pond Life," to which he has alluded. However plainly a particular appearance might be presented to my view, I should hesitate in adhering to its correctness in opposition to so able an observer, if our opportunities had been equal, but in this case I have had the advantage of repeated and prolonged observations; while Mr. Gosse, even in the instance of the "single individual," does not seem to have seen the disk naturally expanded at all, and I conjecture his view of it must have been taken under some peculiar circumstances—perhaps of compression—which disguised its real form. I first discovered the creature—which I cannot reconcile with the description given in Pritchard of the *Cephalosiphon*—in October, 1860, and from a single specimen gave an account of it, which will be found in the *Marvels of Pond Life*. Upon receiving from Mr. Gosse a note expressing his belief that the thing might be a *Cephalosiphon*, although it was certainly not a young *Limnias*, I endeavoured to obtain fresh specimens; but did not succeed till November, 1861, during which month I sent a good many to him at Torquay. Some of them reached that place alive, but from some cause (perhaps not liking the air) not one expanded her disk as in Camden Town. As the weed was abundant, and the creatures plentiful, in the Hampstead pond, I saw no occasion to be in a hurry, and decided not to call the attention of other naturalists to them until Mr.

Gosse had completed his researches. Unfortunately, in the early part of December the pond was cleared out, and I could with great difficulty find a few bits of the *Anacharis*, and still fewer live specimens. I however sent some to Professor Williamson, of Manchester, to whose labours the last edition of Pritchard is so highly indebted.

It will be most convenient if I comment on Mr. Gosse's

FIG. 1.

statements in the order in which they occur. After attentively watching some dozens of the animals in an expanded state. I have never seen anything to justify the idea of the disk being bilobed, with a tendency to further division, and having a "striking resemblance to the expanded wings of a butterfly." The second of the annexed sketches is taken from the *Marvels of*

*Pond Life*, and I still maintain it to be substantially correct, although the attitude is more exceptional than I then thought. In that position the gizzard cannot be seen distinctly, as the observer looks down into the open disk as he would into a tea-cup held with its mouth slanting towards him. The feeler appears surrounded by cilia, and situated near one margin of the rim. This state of things is not common, but I have distinctly seen it since; and it will be understood, on referring to Fig. 1, which also represents an exceptional, but very convenient disposition of parts. In that sketch the proboscis, or feeler, is shown to be seated upon a prominence, which varies in shape, and is capable of considerable motion. When this is thrust forward, the proboscis is carried within the ciliary circle as I first saw it, and as my wife delineated it. The usual attitude of the animal before the disk is opened is like Mr. Gosse's Fig. *e*, the eye however being seldom visible. When the expansion occurs, the amount of protrusion of the body, and the angle at which it is bent, vary indefinitely. Perhaps the commonest position is for the body to be nearly upright, with the upper part bent at an angle like the handle of a walking-stick. The cilia are very long; they vibrate through their entire length, and often exhibit a row of retreating and a row of salient curves. In my Fig. 1, the body is unusually protruded, the projection above the tube, on the left, being the anus. In this sketch the disk is circular and continuous, except immediately in front of the proboscis, where a depression occurs, forming a sort of notch, but not nearly deep enough to justify the epithet "bilobed." I believe the animal can fill up this little notch by bringing the sides together, and relaxing the muscular contraction by which that portion of the margin is pulled down below the general level.

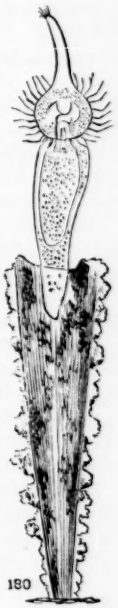

FIG. 2.

The tubes are generally as described by Mr. Gosse, but I have met with a few of unusual length, slightly twisted and strangely bent at the top on one side. In some specimens, probably young, they are transparent enough to allow the animal to be seen all the way to the bottom, and in that state are so flexible as to move about as it moves. What share the fæcal pellets may have in colouring the tubes I do not know; but, with one exception, the darkest food I have seen in healthy individuals has been of a very pale yellow-brown, very much lighter than the flocculent adhesions.

In one individual I observed two rather large oval eggs in the tube, and another adhering to the outside of the tube at the top. These were watched for several days in succession. One morning the outside egg had disappeared, and could not be traced. The animal did not live long enough for the development of the two others to be witnessed.

The disk may require some bending of the body to open it, but it is retained open in all sorts of positions. I have seen the horn-like points which Mr. Gosse describes, but I am at a loss to tell what becomes of them when the creature moves, as, if a glimpse is caught of them one moment, they usually disappear the next. I think the antenna has a piston to which the *setæ* are attached, and which carries them up and down at the will of the creature. On learning that Mr. Gosse had failed to see these bristles (*setæ*), I invited a microscopic friend, and we examined four specimens. In three they were conspicuous with careful illumination and a power of 180, and in one not. They were also seen by Professor Williamson, at Manchester. It is evident they were not everted at Torquay, or they could not have escaped so admirable a microscopist as Mr. Gosse, and one of my specimens did not exhibit them during many examinations. The proboscis is very flexible, and in one instance my wife saw it bent like the forefinger when half closed. My wife also noticed an apparent connection between the inner tubes of the proboscis, and a fine line running round the margin of the disk; which would be consistent with the theory of its being a respiratory organ as well as a feeler. Upon the minute anatomy of the creature I can add nothing to Mr. Gosse's valuable observations, except that the form of the gizzard was one reason why I at first considered it a *Limnias*.

My specimens have usually been very free in exposing their disks, much less easily frightened than the *Melicerta*, and if made to shut up and retract by striking the table, willing to try their fortune again in a few seconds. Once, however, I had a highly nervous lady to deal with, and even a loud noise in the street, or slamming a door in the next house, made her retire in alarm. The same effect was produced by the striking of a small German clock. These creatures have no difficulty in turning about in their tubes, and it is not uncommon to find one opening to the right, retracting suddenly, and then opening to the left, or making other changes equally inconvenient to any one attempting to sketch an accurate portrait.

Their food consists of very small objects, and is often so colourless as to give no aid to the investigation of their internal parts. This circumstance, together with the transparency of the tissues, renders minute observation so difficult as to give

great value to the researches of Mr. Gosse. I should add, that the very striking rings in the foot of that gentleman's central figure, have not been exhibited by any specimens under my notice. My taking this creature for a young *Limnias ceratophylli* arose from a general similarity of structure, and from a remark in Pritchard that the rotary disk of that animal was circular in a juvenile specimen. I have usually found floscules (*ornata, cornuta,* and *campanulata*) on the same weed with the new rotifer, and likewise *Stephanoceros Eichornii.*

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## ANCIENT AND MODERN FINGER-RINGS.

BY H. NOEL HUMPHREYS.

Our modern finger-rings have lost all characteristic meaning in their general form or details. The delicate allusion, the poetic sentiment, the playful conceit conveyed by the graceful forms of interwoven flowers, or other objects, have disappeared. The effect and meaning of the conjunction of various metals in the device is a lost art; and the poetic meaning once attached to gems is a forgotten branch of elegant symbolry. In short, the race of ingenious and artistic artificers, who devised the exquisite jewels of the 15th and 16th centuries, have no modern representatives.

So completely is the art of ring-jewelry forgotten, that it is now sought to give a poetic sentiment to the very defects which mark the degradation of the art; even in the unwrought and unmeaning wedding-ring of our day, a beauty is sought in its absolute want of any characteristic features whatever, by calling it, with a sentimental unction, the *plain* gold ring.

Before, however, I attempt to show what a wedding-ring might be made, and has been made, let us take a brief review of the origin of finger-rings in general.

The earliest kind of rings known appear to have been merely portable seals. In the first great empires of Central Asia of which we have any record, Babylonia and Assyria, the act of sealing was a most important one, and, as an act conferring authenticity upon any important document, stood in the place of the present practice of attaching to it the names of the principal parties concerned. Royal edicts were promulgated entirely through the medium of a seal; the decrees of the Assyrian

kings being engraved upon a cylinder, a kind of rolling seal of cornelian or metal, from which they were impressed upon the requisite number of pieces of prepared clay—thus the seal was, in Assyria and Babylonia, a printing-press, which multiplied the royal edicts to any required extent. Small seals were worn on the royal finger, attached to a ring of metal, and such portable signets were used to give authority to deeds of minor importance. Even private individuals used both the large cylinder, as well as the lesser ring-seal.

The Greeks, so late as the time of Homer, did not use rings or seals, but shortly afterwards, the custom appears to have reached them from the East. In the time of Solon, seal-rings (σφραγίς) appear to have become usual; and with their use the art of counterfeiting them. This was the case also with coined money, as proved by the discovery of ancient counterfeits of some of the earliest kinds of coins known, especially the far-famed Tortoises of Ægina, so called from the highly-wrought image of a tortoise which was the device of the double drachmas of that state. In Athens great precautions were taken with regard to the forgeries of seal-rings; insomuch so, that by a law of Solon an engraver was forbidden to keep the form of the seal which he had sold. These early seal-rings of the Greeks were probably entirely of metal, the custom of mounting engraved gems in rings not having become usual at that period. But already superstition, which in early stages of civilization attaches itself to all things, had begun to attach itself to the seal-ring. The ring of Gyges, king of Lydia, which he is said to have found in a grave, was believed to convey to its possessor extraordinary powers: as was that of Charicleia, mentioned by Heliodorus, and also the famous iron ring of Eucrates.

Magic and rings became closely interwoven in the latter times of Grecian independence; and magic rings, made of wood, bone, or some other cheap material, were manufactured in large numbers at Athens; and could be purchased, gifted with any kind of charm required, for the small consideration of a single drachma.

The simple metal seal-ring was eventually superseded by one composed of gems, richly mounted in chasings of gold; and as luxury increased, several were worn at once, till at last the fingers of both hands were nearly covered with these ornaments; and that too at a comparatively early period, as we find the custom alluded to both by Plato and Aristophanes.

Eventually luxury took the turn of introducing rings of enormous size, and some exquisites went so far at a somewhat later epoch, as we learn from Quintilian, that they had a series of rings suited to the successive seasons of the year—as summer

rings, winter rings, etc., many of them being doubtless of highly ingenious device and finished workmanship. We may imagine the devices to have consisted of such features as gracefully wrought representations of the divinities who were supposed to preside over different seasons—Ceres or Bacchus, for instance, for the Autumn, with jewel-work of wheat and grapes and other fruits; or perhaps, for the same season, the zodiacal sign of the "Scales," to symbolize the equality of the days and nights at the equinox, the figure richly wrought in gold, with the sign of the Fishes, one having, as seen in existing sculptures, rare gems to represent the dishes of the Scales. Or in Spring, the head of a swallow, in allusion to the sun's entrance into that constellation at the period when the swallow first made his annual appearance in Greece, as one of the harbingers of the coming Spring.

There were no legal restrictions in Greece against wearing gold rings, though the Spartans always affected simple iron ones; and the women, it would appear, scarcely pretended to this form of luxury at all, only wearing simple annulets of ivory or amber. This abstinence on the part of the ladies, may have arisen from the fact that the ring, as originating in the seal or signet, was a mark of power or sovereignty, and as such, inconsistent with the general social position of women in Greece.

It is as a sign of authority that a ring is made the means of transferring power, in romantic legends both ancient and modern. "Show this ring to the captain of the guard," etc., is a phrase often found in ancient and mediæval legends, for with the signet the power of the owner might be delegated to any person on whom he chose for a time to bestow it.

In Rome the custom of wearing rings was said to have been introduced through the Samnites, who are described by Livy as wearing gold rings enriched with gems (*gemmati annuli*). Some however state that the Romans adopted the custom in imitation of the Etrurians, in the reign of Tarquinius Priscus. The earliest Roman rings were, however, always of iron, and bearing a stamp or device intended to be used as a seal. To the end of the republic the ancient iron ring was still worn by those who affected to contemn modern luxury and innovation; and among these was Marius, who, as Pliny tells us, wore an iron ring in his triumph after the subjugation of Jugurtha. Eventually, however, not only all patricians wore gold signet rings, but the equites also; and other classes soon imitated their superiors. Eventually, however, legal restrictions were promulgated concerning the right to wear a gold signet. These regulations were afterwards known as the *jus annuli aurei*.

The emperors assumed the power of granting the right of

the annulus aurei, or privilege to wear a gold ring; and this license was much coveted, as it was a sort of patent of nobility, the letter of the law requiring that the fathers and grandfathers of those licentiates should have possessed a property of 400,000 sesterces. At a later period, when the army became the real power in the state, and the Prætorian Guard frequently elected the emperor, the privilege of wearing the gold ring was granted to all soldiers. The keeping of the imperial ring (*cura annuli*) was confided to a state keeper; as the great seal, with us, is placed in custody of the Lord Chancellor. The devices on Roman signet-rings were generally subjects connected with the worship of the gods, or portraits of friends or ancestors; and in many instances persons had engraved upon their seal-rings symbolical allusions to the supposed origin and history of their families. The seal-ring of the dictator Sulla bore for device the figure of Jugurtha at the moment of his being made prisoner. Pompey used a seal-ring which bore three trophies in allusion to his three greatest victories. Augustus first sealed with a sphinx, then with a portrait of Alexander the Great, and lastly with his own portrait. This last custom became very usual; a portrait on the exterior of a letter at once making known its author; just as on the *carte de visite* of a modern exquisite, the photographed perfections of his person identify him at once with his card, without the necessity of a name. Many of the Roman rings were wrought with the greatest skill, both in the designs of the mounting, and the careful engraving of the device; as we learn from numberless exquisite examples still in existence in the great museums of Europe.

It was in the Middle Ages, however, after a period of comparative barbarism in art, that the greatest degree of intricacy in goldsmith's work, and especially in rings, began to display itself. Rich enamel, in curious devices, usurped the place of gems for a time, and designs in *niello* still further heightened the artistic effects of small jewelry towards the close of the 15th century. Benvenuto Cellini, the celebrated Italian sculptor, jeweller, architect, and painter, brought the devices of the ring, the brooch, and the ear-ring to a degree of elaboration and perfection never attained in the whole range of classical art, as far as we know of it, and for a century afterwards it continued to flourish. The quaint conceits of the devices, the effects produced, and sentiments conveyed, by the juxtaposition of various gems, and the introduction of mottoes exquisitely written on waving scrolls, produced a pleasing intricacy of design full of meaning and often epigrammatic point, such as the jewellers of more recent periods never dream of—jewel-making having fallen from all the glory of art into all the meanness of trade.

It may be thought, perhaps, that a modern public would not pay for a careful original design and its careful execution demanding such an amount of artistic labour as would leave the value of the gold and gems employed quite of secondary consideration. But let our jewellers try it. Even in Cellini's time a similar feeling prevailed, as illustrated in a story which Cellini tells of himself. He worked as a student in the shop of one Lucagnolo, a leading goldsmith of the day, but had permission to get other work on his own account. Cellini, while studying an antique statue, attracted the attention of the Donna Portzia Chigi, a princess of the wealthy papal family of that name. As a first mark of patronage, she engaged him to make a gold jewel for her (richly wrought with other devices), but in the form of a lily. Lucagnolo dissuaded him from undertaking the "job," assuring him that those minute and delicate works did not pay; pointing, at the same time, to a large, boldly-embossed, silver vase, that he was making for Pope Clement—one of those dinner-vases used at the time for throwing refuse from the plate during dinner—and assuring his pupil that such large, plain work "paid" much better. The master and pupil made a wager on the subject, Cellini maintaining that his work would prove the more profitable of the two. In twelve days Benvenuto had completed his work, a lily of gold, grouped with miniature fruit, and masks of Comedy and Tragedy, and a number of little devices, which, when submitted to Donna Portzia, gave her infinite delight (Benvenuto does not hide his light under a bushel), and she paid him more than half as much again as the price agreed on. The payment was made entirely in gold, as a token of extreme satisfaction, and accompanied, as he tells us, by compliments "*degne di cotal signora,*" while Lucagnolo only received the exact payment of his work in heavy silver dollars, losing his wager and becoming (as Cellini tells us, with evident self-gratulation) the laughing-stock of the whole goldsmithian fraternity.

In reference to a preceding remark on the modern *plain* gold ring, and as an interesting historic example of the school of jewel-making of the fifteenth and sixteenth centuries, I will annex a representation of the marriage and betrothal rings of Martin Luther. They are not so rich and florid in design as many other examples I might have selected, but, as monuments of the great Reformer and his nun-wife, they have an interest of their own, and sufficiently illustrate a characteristic style of jewel-making which appears to have fallen into a state of collapse that seems beyond the power of all restoration, even by Societies of Arts, or Great International Exhibitions.

The *betrothment-ring* of Luther, which belonged to a family

in Leipsic as late as 1817, and is doubtless still preserved with the greatest care as a national relic of great interest, is composed of an intricate device of gold-work set with a ruby—the emblem of exalted love. The gold devices represent all the symbols of the "Passion." In the centre is the crucified Saviour; on one side the spear, with which the side was pierced, and the rod of reeds of the flagellation. On the other is a leaf of hyssop. Beneath are the dies with which the soldiers cast lots for the garment without seam, and below are the three nails. At the back may be distinguished the inside of the ladder and other symbols connected with the last act of the Atonement; the whole so grouped as to make a large cross, surmounted by the ruby, the most salient feature of the device. On the inside of the ring the inscriptions are still perfect. They contain the names of the betrothed pair, and the date of the wedding-day, in German, "Der 13 Junij, 1525." This was the ring presented to the wife at the betrothal, and worn by her after the marriage.

The *marriage-ring*, worn by Luther after his marriage, is still more intricate in its structure. It is an ingeniously contrived *double* ring, every intricacy of structure having its point and meaning. In the first place, though the double ring can be divided, so as to form two complete rings, yet they cannot be separated from each other, as the one passing through the other causes them to remain permanently interlaced, as an emblem of the marriage vow, though still forming two perfect rings; illustrating also the motto engraved within them, *Was Got zusammen füget soll kein Mensch scheiden*—What God doth join no man shall part. On the one hoop is a diamond, the emblem of power, duration, and fidelity; and on the inside of its raised mounting, which, when joined to the other hoop, will be concealed, are the initials of Martin Luther, followed by a D, denoting his academic title. On the corresponding surface of the mounting of the gem of the other hoop are the

initials of his wife, Catherine von Bora, which, on the closing of the rings, necessarily lies close to those of Luther. The gem in this side of the ring is a ruby, the emblem of exalted love; so that the names of Catherine and Luther are closely united, when the rings are closed, beneath the emblems of exalted love, power, duration, and fidelity.

There can be but little doubt that these curious and interesting rings were designed by the celebrated painter and goldsmith, Lucas Cranach, and possibly wrought with his own hand, the marriage of his friend Luther being a special occasion which he doubtless wished to honour with every attention in his power. Lucas was, indeed, one of the three select friends whom Luther took to witness his betrothal, the others being Dr. Bugenhagen, town preacher of Wittenberg, and the lawyer Assel, who all accompanied him to Reichenbach's house, where Catherine resided.

In the rings above described there is, doubtless, such device, and meaning, and exquisite workmanship, as the Donna Portzia Chigi of the present day might assuredly reward with something more than the market-price, if produced by our jewellers, and pay for in gold, too, if the fitting opportunity should present itself, not omitting even the compliments *degne di cotal signora.*

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## THE EARTH IN THE COMET'S TAIL.

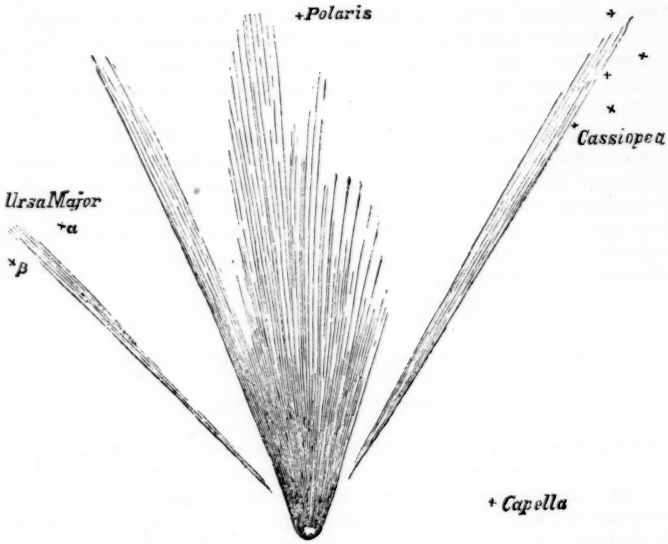
BY THE REV. T. W. WEBB, F.R.A.S.

THE reader will, no doubt, recollect the remarks that were made by several persons, and in various places, as to something unusual in the appearance of the evening of June 30th, 1861, and the interest subsequently attached to them by Mr. Hind's calculation that at that very time, or a little earlier, the tail of the great comet might, in all probability, have been enveloping the earth. The following additional and independent testimony to that conjunction is the more worthy of remark as being drawn from a perfectly different mode of observation.

On the night in question, after I had, like so many others, been astonished by the sudden appearance of the comet, and had studied and sketched the nucleus with its marvellous train of six envelopes, and had dismounted my telescope with the impression that there was little more that I could do, as well as in anticipation of the approaching moonlight, my attention was drawn by my wife, about 11h. 45m. to a faint ray, perfectly similar in appearance to the tail, lying nearly horizontally in the W.N.W. beneath the quadrilateral of Ursa Major, about

XUM

3° or 3½° broad, having $\psi$ Ursæ in its lower edge, and Cor Caroli about 1° above its upper, and traceable about half-way from the latter star to Arcturus: it pointed to the head of the comet, but in the twilight of the northern horizon no connection could be distinguished. About twenty minutes later it had risen higher, so as to stand midway between $\psi$ and $\gamma$ Ursæ Majoris, and its termination near $\epsilon$ Boötis was now plainly visible, much more so than previously, this part of the streak having become equally bright with the rest, and perhaps even brighter. Some time afterwards I could no longer see it, so that




*Night of June* 30, *July* 1, 1861, 12*h.* 30*m.* (*about*).

I concluded that it was probably only a cirrus cloud brought up by the N.W. wind then blowing; and this impression was confirmed by my erroneous idea that as the comet was evidently moving rapidly away towards the N.W., this ray, had it been a branch of the tail, ought to have rather sunk than risen in the sky. Fortunately its peculiar appearance and direction induced me to record it in all its details; but so backward was I to recognize its true character, that in a communication to the "London Review," in which it was mentioned, I had expressed a doubt whether the tail was sufficiently expanded to correspond with its supposed vicinity to the earth, when I received a letter from

George Williams, Esq., of Liverpool, which entirely altered my view of its nature. From his statement it appears that about 12h. 30m. he had seen the same ray in the direction of Ursa Major, as well as another, somewhat brighter, which diverged towards Cassiopea, the brightest part of the latter being at some distance from the comet, and appearing to recede from it until it was altogether lost. Like myself he had thought at the time that both might be cirrus clouds only; but that each should point to the nucleus of the comet, he considered a circumstance worthy at least of a remark, and he, therefore, recorded the appearance in a beautiful sketch, which I have his obliging permission to make use of, and of which a copy is here given. It was not surprising that I had missed the eastern ray, as that part of the sky was partially obscured by trees from my station at the telescope, and was wholly invisible afterwards from the window; but we had previously noticed that the right side of the tail had appeared to the naked eye to strike out from the coma for a few degrees in a more easterly direction; this, though not traceable as a separate stream, was, I have little doubt, the point of departure of the ray in Cassiopea. Thus it seems established, by the concurrence of two observers at distant stations, that these rays were not clouds, but the perspective representation of the sides of a conical or cylindrical tail, hanging closely above our heads, and probably just being lifted up out of our atmosphere. The rapid movement which I had noticed in the western beam, and which, according to Mr. Williams' sketch, was still continued afterwards, will, on careful consideration, be found in full accordance with this idea: for the tail was then receding so speedily from the earth that the sides of the outspread fan must, from the effect of perspective, have closed up with great swiftness towards the centre, and thus would be produced that apparent rising in the sky by which I was misled: the great amount, too, of that closing up in proportion to the time of the observation, shows how very near the object must even at that moment have been to us; and yet the central streams must obviously have been considerably closer to us than the apparent sides of the cone or cylinder. So that, from a review of the whole phenomenon, it seems not only certain that we were then in the immediate vicinity of the tail, but much more probable that we had actually passed through it, as Mr. Hind supposed, than that there still remained, according to the German astronomer, M. Pape, an interval of two millions of miles.

The next night proved cloudy, and I never saw ths western ray afterwards, but it may have been the same with that noticed by some observers on July 10 as deviating towards the star $\mu$ Boötis.



XUM

The want of entire continuity in these external streams would form no argument against their cometary character, even had it not been established by observation at two distant stations. The interruption might be only apparent, the result of the position of the nucleus in the bright midsummer twilight of the north horizon; but if real it would not be unprecedented. In the very curious comet of alternating light in June and July, 1860, one of the two sides of the tail was, towards the latter part of its appearance, separated from the head; and in that of 1843, so remarkable for its visibility close to the sun at noon-day, the splendid tail which had been darted out to such an amazing length had at one time no connection, visible to the naked eye, with the pale and seemingly exhausted nucleus. And so in the case of those "anomalous tails," those most inexplicable pencils of light, which are occasionally directed from the nucleus towards the sun, two instances are on record (in 1824 and 1845) in which they contained a fainter interval.

Admitting the probability of our passage through the tail, it cannot be thought surprising that there should have been at the time so little sensible indication of its presence. Whatever may be the nature of that wholly unknown material, there can be no question of its extreme and almost inconceivable attenuation. The air we breathe may be as dense in comparison with it, as water or even earth in comparison with air. The minutest stars have been frequently seen through thousands of miles of it, and it even ceases to be amenable to the all-controlling force of gravitation; so that Newton considered that the tail of a great comet might be compressed into the bulk of a single cubic inch before it would equal the density of our atmosphere, and Sir J. Herschel supposes that it may not contain more than a few pounds or even ounces of matter. It would, therefore, be highly improbable that there should be a sufficient quantity of it in the immediate vicinity of any one place of observation to render its presence manifest. Distance alone, by bringing its particles into more apparent concentration, could give it density enough to become perceptible, just as the same cause converts the unsubstantial and semi-transparent mist into the massive and ponderous-looking cloud. It was a more significant fact, and one which may not be generally known, that no electric or magnetic effect whatever was perceptible during its passage;* for such influences have been strongly suspected in cometary phenomena, and might act independently of any material admixture. We have certainly gained very little information, and less, perhaps, than might have been

* Some lofty cirri, however, the next morning, had a singularly wild and electrical aspect; and the Greenwich instruments showed a strong change the following night.

reasonably expected, from that memorable conjunction; but at any rate a great proportion of the terrors of ages has now been dispelled; we have found that we have neither deluge, nor conflagration, nor pestilence, to fear from the encounter of a comet's tail. There remains, indeed, the chance, an almost incalculably smaller one, that we might come in contact with a nucleus; and what might be the consequence of a close conjunction with that wholly unknown and most mysterious material it is, of course, impossible to say. We have no analogy whatever to guide us, and notwithstanding what has recently occurred, no experience to give us aid. It is certain that the nucleus consists of ponderable matter, since it obeys the law of gravity; and that it possesses the power of either originating or reflecting a vivid light; but beyond this, as its nature is wholly unknown, so must be the result of its collision. But no ground for apprehension on this subject exists. We need not have recourse to Kepler's idea of a guiding intelligence for our sense of security, while we are certain that every orbit is planned out, without the possibility of deviation, by infinite wisdom and paternal goodness; and that "known unto GOD are all His works from the beginning of the world."

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## JOTTINGS ON COPPER.

### PERCY'S METALLURGY.*

THE publication of Dr. Percy's "Metallurgy" affords a convenient opportunity for considering some interesting properties of copper, a metal which, next to iron, has been most conducive to human civilization, and which in various shapes still plays a very important part in industrial and domestic life. It appears that its English appellation originates in the fact of its early discovery by the ancients in the island of Cyprus, whence came the adjective Cyprian, corrupted into the substantive *cuprum*, from which the word copper was obtained. With the exception of titanium, it is the only metal exhibiting a red colour, which is sometimes shown very strikingly when minute irregularities of the surface cause a peculiar play of light. It is well known to possess the valuable qualities of malleability and ductility in a high degree; but its physical properties are easily modified. Thus cold rolling or hammering makes it hard and brittle, the malleability being restored by annealing at a red heat. As it ap-

* "Metallurgy: The Art of Extracting Metals from their Ores, and adapting them to various Purposes of Manufacture." By John Percy, M.D., F.R.S., Lecturer at the Government School of Mines. Murray.

XUM

proaches the melting-point, which lies between those of gold and silver, "it becomes so brittle that it may be readily reduced to powder by trituration," and workmen in foundries avail themselves of this property when ingots have to be broken up. It is customary to judge of the quality of the copper from the fracture thus produced. This is, however, a very inadequate test; and Dr. Percy relates an instance of a large quantity of copper being rejected at one of the dockyards on account of the appearance of its fracture, and which was afterwards accepted when it had been remelted and "laded" at a different temperature. We shall presently have something more to say on the peculiarities of naval mismanagement in reference to copper sheathing, but must first allude to the action of oxygen and other substances in affecting the quality of the metal in its various states.

There are probably three oxides of copper, of which only two are considered by Dr. Percy to concern the metallurgist: one the protoxide, consisting of one equivalent of copper and one of oxygen ($Cu^2O$), which is the basis of the ordinary salts of the metal. The other is the dioxide, consisting of two equivalents of copper and one of oxygen ($Cu^2O$). This is the red oxide, but Dr. Percy says it constitutes a principal portion of the dark-coloured scale formed when the metal is heated to redness with access of air, and we shall find it has an important action in the various processes to which the metal is subjected, in order to fit it for the uses of man. In a state of fusion, copper is able to dissolve this oxide; and when it is present in considerable quantities, the metal is brittle, whether hot or cold, and is technically designated, by the smelters, "dry." Rather more than one per cent. of dioxide is stated on the authority of Karsten to render *pure* copper incapable of being worked in ordinary temperatures without splitting into laminæ, and cracking it at the edges. Ordinary copper, however, which contains lead and other impurities, actually requires a certain portion of the dioxide to make it tough and malleable; and if the oxygen be removed by exposing "tough copper," in the state of wire or foil, to the action of dry hydrogen at a red heat, the metal becomes so brittle that it cannot be bent without breaking. Unfortunately, very little is known concerning the nature of this curious action of the dioxide, or of the proportion it should bear to other impurities in order to afford the best result. The copper annually wasted in the dockyards, for want of this and some other technical knowledge, is worth an enormous sum; but no government has hitherto exhibited enough intelligence to pay the comparatively insignificant cost of a set of experiments by which many intricate questions connected with the metallurgy of copper might be set at rest.

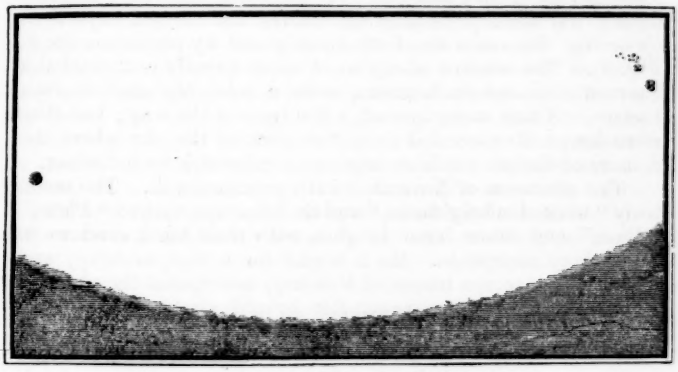
Having thus briefly adverted to the effect of oxygen on copper, we must select, from various important combinations, those which are alleged to take place with carbon, and which are known to occur with silicon and phosphorus. Let us commence with carbon, which was presumed to be chemically combined with copper during the process of *poling*, and to give rise to the brittleness of what is called "overpoled copper." These terms will be understood when it is explained that one of the processes of copper-melting consists in plunging a thick pole of oak or birch, in a green state, into melted metal which contains a good deal of dioxide; anthracite, or "pure free-burning coal, being previously thrown on the surface. The wood in contact with the copper is rapidly decomposed, much gas and vapour are evolved, which cause the metal to be splashed about, and every part of it to be exposed to the reducing action of the coal upon its surface." The chief effect of this process is that of deoxidar tion; but it obviously provides conditions under which coppe- and carbon might unite, if their chemical affinities so decide. When the poling is carried on to the proper extent, the copper becomes tough by the removal of the superfluous oxygen. If, however, it is carried on too long, it is made brittle, in accordance with what has been stated of the use of a small quantity of dioxide in copper that is impure. Dr. Percy requested Mr. Dick to make a number of experiments to ascertain what action the carbon exerted, and although their results do not justify the assertion that small quantities of carbon may not combine with the copper and affect its properties, he ascertained that "comparatively pure copper is not rendered brittle by being heated or melted in contact with comparatively pure charcoal."

If copper is heated to whiteness in contact with silica and carbon, a compound is obtained which resembles gun-metal in colour, and is tough and much harder than copper. It may be rolled or hammered out while cold, but cracks under such treatment at a red heat. A proportion of 1·82 per cent. of silicon gives an alloy tougher than gun-metal, and probably adapted to manufacturing use. Much larger proportions induce brittleness. A still more interesting compound is obtained by dropping phosphorus—which should be covered with an electrotype coating of copper—into the metal in a melted state. In the Laboratory at Woolwich many experiments were made, of this nature, with a view to obtain a material adapted to the manufacture of rifled guns; but the improved modes of working iron, employed by Armstrong or Whitworth, threw them into the shade, as far as this special object was concerned. The quality of this compound varies with the proportion of phosphorus; 11 per cent. giving great hardness, but rendering the metal brittle. Perhaps the most interesting feature of the

XUM

union of phosphorus and copper is the apparent capacity of the alloy to withstand the action of sea-water. It seems that, in 1848, Dr. Percy furnished Colonel Sir Henry (then Captain) James with various specimens of copper, which he placed in sea-water for nine months, and the result appeared so completely to establish the protecting influence of phosphorus, that the Admiralty was induced to grant £50 for further experiments; and accordingly Dr. Percy caused more plates to be made, in which ½ per cent. of phosphorus was introduced. These sheets were placed upon buoys in three different dockyards, and after a year or two, all that could be ascertained was that the authorities had caused them to be "painted all over." Some years after this, Sir Henry James discovered that the phosphorized sheets had resisted corrosion twice as well as others with which they had been compared; but the "Board," that serviceable screen for jobbery and ignorance, could not be induced to take further steps in the matter.

We have not pretended, in these brief remarks, to write a review of Dr. Percy's work. As might have been expected from the author's opportunities and reputation, it contains a large amount of important matter; but we confess it does not appear to us to have been sufficiently digested. It is not a very convenient book for reference, nor does it exhibit that faculty of generalization which characterizes the higher kinds of scientific works. It was also an error to issue it as if it had been a complete treatise. It is a misnomer to call it "Percy's Metallurgy," of which it is no more than the first volume—only two metals, copper and zinc, being dealt with. It may likewise be questioned whether it was judicious to devote so many pages to such matters as charcoal and coke burning; and we should imagine most students would have preferred the omission of elaborate details of this kind, in order that more of the actual science of metallurgy might have been condensed in a given space. The remainder of the work is promised during the current year, and when it is all before us, our opinion of its merits may be materially improved.



A PLANET'S SHADOW.

The Shadow of the Planet Mercury, and of a group of solar spots, as shown on a sheet of paper during the Transit of Mercury, Nov. 12, 1861, 8.30 a.m.

## THE TRANSIT OF MERCURY ON NOV. 12, 1861.

BY THE HON. MRS. WARD.

"A TRANSIT of Mercury will happen on the morning of Nov. 12th. . . . The planet, at sunrise, will appear on the sun's disc, as a perfectly round and intensely black spot." So said the almanacs for 1861; and no doubt more than one possessor of a telescope added the query, not to be answered for nearly a year,—"Shall *I* see it? will fine weather, a favourably situated horizon, and personal life and health, combine to give me the pleasure of seeing a phenomenon which has not occurred for thirteen years, and will not, after this transit, occur again for seven years to come?" *

Such were my thoughts on being reminded that the transit of 1861 was *coming*, and no longer to be looked on as an event in the remote future. Time passed on its stormy way; the grand comet of June came unannounced, and disappeared in the distance; and November 12th found me surrounded by many favourable circumstances for viewing the transit. I was absent from home, but had borrowed an old and rather good

* The transits of Mercury which have occurred during the present century, were in the years 1802, 1815, 1822, 1832, 1835, 1845, 1848, and 1861. Those still to occur, will be in 1868, 1878, 1881, 1891, and 1894. They occur either in May or November, since, from the position of the orbit of Mercury, the planet can only pass between the earth and the sun, and near enough to a line joining the two bodies, to be seen upon the solar disc, in one or other of those months. (See Johnston's "School Atlas of Astronomy.")

telescope (by Tulley and Sons) of two inches' aperture, and had during the week preceding the transit accustomed myself to observing the sun's disc both directly and by projection (as in Fig. 3). The window of my room most happily commanded a view of the *eastern* heavens, with a tolerably unobstructed horizon. There were, indeed, a few trees in the way; but they were low, and concealed only that part of the sky where the density of the air would in any case render objects indistinct.

The afternoon of November 11th promised well. The moon truly "walked in brightness," and the telescope showed "Plato," "Pico," and other lunar heights, with their black shadows in satisfactory sharpness. So I hoped for a fine morning, and having never seen a transit of Mercury, anticipated the pleasure with some of the eagerness felt by old Gassendi, the first observer of such a phenomenon.*

On November 12th, I looked out at about a quarter to seven in the morning. Delightful sight! the sky was perfectly cloudless. The brightest stars were disappearing in the increasing light of morning, but Jupiter and Saturn still glittered in the south-east. The light of Saturn was nearly "burnt out in the pale blue air," yet its exquisitely delicate ring could still be detected, giving more the idea of a *film* than of a definite line on each side of the planet.† (Fig. 1.)

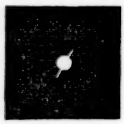


FIG. 1.

While Saturn remained visible, I felt I had time to spare, but when he disappeared, and even Jupiter's light waned, then I knew the real work of the morning was coming. Redder and rounder grew the glow of light exactly behind a small tree. Soon it sparkled through the branches, the sun had risen! and while yet only a semicircle, my telescope was there to watch it, its outline waving like rippling water.‡ But the disk rose grandly from branch to branch. Very curious was the effect,

* On November 7th, 1631, this transit, predicted two years previously by Kepler, was observed by Gassendi, Professor of Mathematics in the University of Paris. The next transit of Mercury which was observed, was on November 3rd, 1651. A young Englishman, named Shakerley, had found by calculation that this transit would be visible only in Asia, and he proceeded to Surat in India for the express purpose of witnessing its occurrence. He was successful in the object of his pilgrimage; and the anecdote remains as one of the romantic episodes of astronomy.

† The ring of Saturn became edgewise to the earth, though not yet so to the sun on November 23rd. It was, therefore, barely visible on November 12th; and on November 23rd I observed Saturn as a round disk without the slightest trace remaining of its ring.

‡ The rippling motion observable on the outlines of the sun, moon, and other heavenly bodies, is quaintly but well described by Derham. His descriptions, from original observations, are interesting from their freshness and truth; ever fresh and new, like the grand objects they describe. I quote from "Astro-Theology," sixth edition, 1731:—"There are some certain transient Roughnesses and Uneven-

when, the sun itself out of focus, I allowed it to project on paper the shadows of the intervening branches. Every twig, and every lingering ash-leaf, parched by the sere winds of autumn, but not yet fallen to earth, were shown in singular sharpness and waving in the breeze. Curious, too, when looking directly at the sun through the dark glass of the telescope, anxiously waiting its arrival behind a somewhat thinner part of the tree, a little pert tomtit or robin hopped to and fro, unconscious that he too was performing a transit across the sun's disk for my benefit. The bird was out of focus, the sun was in; and a few minutes later, came to more thinly crossing branches; (Fig. 2), and there, on his disk, was the unmistakeable BLACK

**FIG. 2.**

First View of the Planet Mercury, on the Sun's rising above some branches of a tree.

DISK OF MERCURY! It was nearer to the edge than I had expected to see it, and (truth to tell) it was very small; but exactly of the size which I knew it would appear, judging by the measurements of the sun, and of Mercury and the other planets, always given in Dietrichsen and Hannay's Almanacs.

The difference of longitude between Greenwich and my position (Kingstown, near Dublin) is about twenty-five minutes of time. Hence, when the sun rose at Kingstown, the planet had not only accomplished half of its transit (as was the case two minutes after sunrise at Greenwich), but had been more than

nesses on the Limb caused by Vapours, especially when the Moon is near the Horizon, and in windy and some other Weather. At which Times, the Motion of the Air and Vapours makes a pretty Crispation and Rouling, like Waves on the Moon's Limb, which have the appearance of moving Mountains and Valleys."

twenty minutes in retreat. I forgot this; and therefore when I descried the planet as above, at 8 A.M., I supposed I had still an hour and eighteen minutes in which to watch the transit, because it was to be over at 9h. 18m. This 9h. 18m., however, was but 8h. 53m. of Dublin time. Yet I have not to regret any idleness during those fifty-three minutes, the like of which are not to happen to me again for seven years, if ever again. I sketched the sun and the planet and s r spots repeatedly. I viewed them directly and by projection; and I called just one "witness to my Strange Site in the heavens," as the coastguard man wrote, who discovered Donati's comet, somewhat early in its career of celebrity. That witness came in good time to see it appearing when projected on paper, exactly as shown in the illustration which heads this narrative. To show it in this manner, the telescope was arranged as in Fig. 3, the window shutters being partly closed, and the curtains drawn, to add brilliancy to the effect. It struck me as a very curious circumstance that it should ever be possible to bring the veritable *shadow of a planet* into one's own room!

FIG. 3.

The figure heading this narrative gives a small portion of the solar disk as it appeared when projected on paper; it was not only *inverted* but *reversed*; that is to say, it was turned upside down, and shown, as in a looking-glass, left for right. The edge of the disk is to be imagined in constant undulating motion.

The sun, as observed directly with the telescope at this time, was as in Fig. 4. And now the planet rapidly neared the edge of the disk. I regretted much the low power of the telescope, as it prevented my looking out for some curious effects of irradiation which are said to have been observed on the entrance and departure of the planet during former transits. When the upper outline of the planet touched that of the sun (Fig. 5), I watched it intently; noting, however, nothing except that it took a considerable time to slide completely out of sight. It appeared as a *notch* on the sun's edge, becoming smaller and

shallower, till at last it could no longer be distinguished from the rippling outlines of the sun. I then looked at a watch (one however which has the failing of being generally two or three minutes slow), and the time marked was eight minutes to nine.

Fig. 4.

And so the transit ended; the impression on my mind of a real movement having been best conveyed at its close, as it then became evident that the planet was passing out of sight. I thought the planet showed best as an *unusual* object, about ten minutes before its disappearance, that is to say, shortly before its upper edge touched that of the sun. The sun, through a telescope, always gives me the true impression of being a globe, not a disk. The solar spots as they come into sight or recede from view by the sun's rotation, are always foreshortened, as the engraved pattern, for instance, on a lamp-shade would be. Close to the sun's edge they are extremely slight and thin marks. But Mercury's shape, continuing unaltered, contrasted well with the solar spots. It was as though a small grain of shot were suspended in front of an illuminated lamp-shade.

Fig. 5.

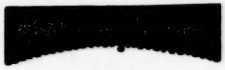


Fig. 6.

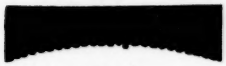


Fig. 7.

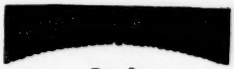


Fig. 8.

Mercury passing off the Sun's disk; the movement being from right to left, in the direction of the arrow.

The contrast to the solar spots was far less striking when the planet was nearer to the centre of the disk. But, in truth, the sight was altogether suggestive rather than striking, and was not very truly characterized in a newspaper paragraph which referred to it as "a grand phenomenon."

# PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

[It is proposed, under the above title, to give each month an account of the more interesting communications laid before the different learned and scientific societies.]

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## ENTOMOLOGICAL SOCIETY.—*January* 6.

On the Artificial Production of Varieties in Insects.—An animated discussion took place on a paper entitled, "Notes on Variety Breeding," read by Mr. C. S. Gregson before the members of the Northern Entomological Society at Manchester. The author of this paper says: "After years of careful study of the habits and food of insects, I determined to ascertain if a change of food would give a change of colouring and marking to species liable to sport, and during the last ten years I have been pursuing my experiments. The results of my experience go to prove that most unquestionably many species, some of them hitherto not often thought liable to vary, may be cultivated into varieties. For instance, *Bucephala*, fed upon sycamore, is much finer and darker than when fed upon any other food, though it is well known that this species is never found upon that tree in its natural state. After enumerating many variations produced by changing the food of the larvæ of insects the author stated, "What will, perhaps, interest you most to know, and undoubtedly what I know best, and have oftenest tried and succeeded in producing, is, that *Arctia caja*, fed upon *Petasites vulgare*, or upon the common colt's-foot, will produce darker specimens than when fed upon any other plant; and the chances are, that when fed upon this food, some of the specimens will prove extraordinarily dark. But there is a singularity in the fact that the darkest specimens so bred rarely open their wings." In opposition to the objections that such variations were the result of disease, it was shown that many of the specimens so varied were of larger and finer growth than the ordinary specimens. In the course of the remarks on this subject, Mr. J. Lubbock suggested the importance of ascertaining the effect of feeding successive generations of the same insect with substances calculated to produce variations, and expressed a hope that some entomologists would extend the observations over a series of years.

On the Causes which Influence the Production of a Fertile Queen Bee from a Worker Egg.—At a previous meeting of this Society, Mr. Tegetmeier called attention to a new theory, advanced by the Rev. Mr. Leitch, to account for the development of a queen bee from an egg, which, under ordinary circumstances, would produce a sterile worker. This fact, well known to all practical apiarians, was supposed by Huber to be effected by feeding the

insect, whilst in the larval state, with a peculiar food termed royal jelly. The change, however, is always attended by an alteration in the size and position of the cell holding the future queen, which is enlarged and extended away from the plane of the comb, and in all cases turned downwards so as to assume the perpendicular position. The Rev. Mr. Leitch's experiments prove that the position of the queen cell is not of importance, as he inverted it in some cases, and in others placed it horizontally, but the queen was developed with equal certainty. He suggested that the cause of the more perfect development of the inclosed larva was due to the increased temperature to which it was subjected, and that it was drawn out from the other cells in order that it might be exposed on all sides to the warmth generated by the respiration of the bees that always cluster closely around the royal cell. At the present meeting Mr. Smyth read a paper, from Mr. Woodbury, maintaining the older theory, and stating that the transformation of any given worker egg or young grub into a queen, could be determined by placing a small amount of the food taken from a royal cell, and known as royal jelly, on the edge of the worker cell. In reply it was alleged that the food theory offered no explanation of the remarkable change of position that always is made to accompany the transformation, and the general opinion of the members present seemed to favour the view that the more perfect development of a worker egg or grub into a queen bee depended not upon one cause only, but was influenced by the threefold conjoined causes of increased, and probably altered food, enlarged size of cell, and greater elevation of temperature.

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## THE ROYAL SOCIETY.—*January* 9.

THE PRODUCTION OF SOUNDS AND VISIBLE VIBRATIONS BY VOLTAIC CURRENTS.—Mr. Gore furnished the following particulars respecting the production of vibrations and sounds by a voltaic current. It is found that when a voltaic current of suitable intensity, is passed by a mercury anode through a solution of ten grains of cyanide of mercury, one hundred of hydrate of potash in two ounces and three-quarters of hydrocyanic acid (containing five per cent. of the anhydrous acid), into an annular cathode of mercury, two or three inches in diameter, and one-eighth of an inch wide, visible vibrations of the negative mercury, accompanied by sounds, are produced; and the current, instead of being constant, becomes intermittent. If a voltaic current, from about eight Smee's elements, with large surface, is employed, the vibrations are small, and the sounds produced are high in musical pitch. If, however, another current of the same quantity (as determined by a voltameter), but resulting from a greater number (say twenty) elements of small surface, be employed, then the vibrations are large and the pitch of the sounds low or bass. These differences are still more conspicuous if a galvanometer of small resistance, with a short thick wire, be employed instead of a voltameter, and four Smee's cells be used instead of eight. If a current proceeding from two cells of a Grove's battery be passed through a

XUM

primary coil consisting of 250 feet of thick copper wire, the vibrations are moderate in size and the sound of medium pitch. When a core of iron wire is placed in the centre of the copper coil, the vibrations become larger and the sound more bass. If this primary coil is surrounded by a secondary coil consisting of 4000 feet of fine wire, having the ends closed, and the core of iron wire is absent, the vibrations become very small and the pitch of the sound very high, these variations occurring although the current remains unchanged. It was found that if a battery of greater intensity be employed (say one of twenty Smee's elements), these remarkable effects were not produced. The inference drawn by Mr. Gore from these experiments was, that voltaic electricity, like heat and light, may be viewed as consisting of vibrations, which are ordinarily inappreciable, but which, under certain conditions, such as these described, may be gradually increased so as to become visible. These results are evidently worthy of the most attentive examination; their value as tending to elucidate the nature of voltaic electricity, can hardly be overrated, although it is evident that a sufficient number of facts are not yet accumulated to prove the inference that has been deduced.

On the Existence of Posterior Lobes in the Brain of Quadrumana.—Mr. W. H. Flower communicated some additional observations on the existence of the posterior lobes of the cerebrum in various genera of *Quadrumana*, as *Cercopithecus*, *Macacus*, and *Cebus*. These lobes also exist in *Presbytes* and *Hapale*, between the brain of the last and that of man, which are at opposite ends of a very extensive series, there is a gradual gradation, although in both posterior lobes exist which present certain characters in common. In the Lemur the recent brain presents the sylvian fissure, median lobe, calcarine sulcus, and general characters of convolutions, which prove that the brain of animals of this family is formed on the same general type as that of the higher *Quadrumana*. The gradation from the brain of *Homo* to *Hapale* is regular and gradual. The *Lemurs* are not, however, in the same line of degradation, but form a sub-series, which is parallel to the lower part of the larger group, this sub-series being distinguished by the shortness of the posterior lobes, the large size of the olfactory bulbs, and the inferior development of the cerebellum.

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## ROYAL GEOGRAPHICAL SOCIETY.—*January* 13.

Intelligence of Burke's Exploring Expedition.—In the absence of Lord Ashburton, Sir Roderick I. Murchison took the chair. In opening the meeting he read the address of condolence which had been presented by the president and council of the Society to her Majesty on the occasion of the lamented death of H. R. H. the Prince Consort. He then proceeded to say that by the mail of that morning he had received two deeply-interesting communications—one respecting Australia, and the other concerning explorations on the coast of Eastern Africa.

The letter and inclosures from Sir Henry Barkly, the governor of Victoria, conveyed intelligence of the successful crossing of the Australian continent by the expedition under the command of Mr. R. Burke; but at the same time told of the lamentable death of the leaders after their return to Cooper's Creek. They had accomplished the journey from Cooper's Creek to the banks of a river flowing into the Gulf of Carpentaria, by them supposed to be the Albert, but considered (according to corrected calculations) to be the Flinders River. They returned to Cooper's Creek, only to find the depôt abandoned by the party who should have awaited their return, and who, indeed, had only left the station a few hours before the arrival of Messrs. Burke and Wills, with King, their assistant. Provisions had been left for them, but the party were too much exhausted to travel on. Mr. Burke and Mr. Wills died of starvation, and the sole survivor of the expedition is King, who has been brought back to Melbourne. The object of the journey has been fully accomplished. A fertile tract, with wood, water, and pasture land, lies between Cooper's Creek and the Gulf of Carpentaria; and an opportunity is thus afforded for founding a settlement on the northern shores of the Australian continent.

The second communication was from Mr. Thornton, the geologist attached to the expedition of the Baron von Decken, on the coast of Africa, near Mombas. Mr. Thornton has fully explored the coast country from some distance inland, and has laid down several lakes and rivers. But the most important intelligence is that which he sends concerning Mount Kilimanjaro. Some discredit has been thrown on the statement of Mr. Rebmann, the missionary, that this mountain is covered with snow. Mr. Thornton, who has ascended Kilimanjaro to the height of 8000 feet, says that the summit of the mountain (which rises to 20,000 feet) is snow-covered, and that the snow lies in patches for a considerable distance down its sides. Further, on the north-east, south-east, and south sides, which are those that he has explored, there are distinct evidences of volcanic action in the lava-streams that have at one time poured down the mountain.

The papers of the evening, "On the Andaman Islands," and "On the Trade of New Guinea," were then read by Dr. Mouat and Mr. Galton.

The Andaman Islands were visited in 1859 by a party under Dr. Mouat, with the view of re-establishing on the Great Andaman a penal settlement. A short history of the group was given, and an account of the survey of the islands. The Great Andaman was stated to be not one island, but three, divided from each other by narrow straits, extremely difficult of navigation. The islands are of volcanic origin. The highest peak, 2400 feet, is found in the north of the Great Andaman, and the peaks gradually decrease in height from north to south of the island. All the elevations have steep descents on their northern sides, and slope gradually towards the south. The whole of the islands are covered with a dense tropical vegetation, and forests of mangrove line every part of the coast. The natives of the Andaman Islands are a peculiar people, short of stature, never exceeding 4 ft. 9 in. or 4 ft. 10 in. in height, little

XUM

advanced in the arts of civilization, building wretched huts, but using canoes, employing bows and arrows as implements of war, brave, kind to each other, careful of their children, but extremely hostile to strangers. Most that is known about them has been gathered from the statements of two convict sepoys who escaped from the settlement at Port Blair, but voluntarily returned after having lived some time with the Andamaners.

A short paper on the trade of New Guinea was read, and then Sir R. Murchison called on Professor Owen to speak on the subject of the natives of the Andaman Islands. He said that Dr. Mouat had sent to him the only skeleton of an Andamaner that had ever reached England. He had found it to be that of an adult male in the prime of life, showing evidence, in the texture of the bones and the development of their parts, of having belonged to an individual who, though small of stature, must yet have been of accurate proportion. He had been most interested in the examination of the cranium, which he had expected to find allied to the Papuan or to the Negro variety. He had found, however, that the skull exhibited none of the characteristic peculiarities of the Papuan, and still less of those of the Negro; that it had no affinity with the Malay or the Mongolian type of cranium: in fact, that with the exception of the prognathous jaw-bones, in its classic oval and in its general proportions, it was most nearly allied to the skull of a Caucasian. In the course of his investigations some suggestions had presented themselves to him. Why is it necessary that, in determining the race to which the inhabitants of detached groups of islands belong, we should expect to find invariably that they are connected with the inhabitants of conterminous continents? In the case of many of these islands, particularly of Ceylon, it had been shown that the geological age of the island was much earlier than that of the adjacent mainland. Why, then, might not the inhabitants of such groups of islands be the descendants of races who had peopled continents which no longer exist, but of which these islands are the remains, and in comparison with which the present continents in the *eons* of geologic history are of very recent date? These are but suggestions. One thing, however, is certain, that the Andamaners, from whomsoever they may be descended, are *men* just as much as the inhabitants of any other portion of the globe, and that their frames are suited to enable them fully to enjoy their life in the situation in which they are found.

Mr. J. Crawfurd, F.R.G.S., president of the Ethnological Society, agreed with Professor Owen in what he had observed, and said that he might state, from his own experience, that natives of the Andaman Islands were capable of receiving training, and had been made very good household servants.

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## ZOOLOGICAL SOCIETY.—*January* 14.

Habits and Structure of the Aye aye.—Professor Owen read an interesting description of the habits of that singular animal, the

Aye-aye, of Madagascar, which had been kept in confinement by Dr. Sandwith. The Aye-aye is an arboreal animal, about the size of a cat, with grasping hands and the teeth of a rodent, the forehand has a short opposable thumb, but is most strikingly distinguished by the very long and extremely attenuated character of the middle finger, which has the appearance of being deformed. The use of this remarkable structure was rendered evident when some branches, the wood of which had been perforated by large larvæ, were placed in its cage, when the thin finger was employed by the animal as a sounding instrument, being used in tapping, and as a probe to feel for and extract the grubs, which were immediately devoured with great relish; the peculiar teeth of the animal, which are formed on precisely the same type as those of a gnawing animal, enabling it to gnaw away the bark of the branches and a sufficient quantity of wood to allow it to reach the grubs. The animal feeds also on vegetable food, as dates and other fruits. The specimen, after remaining some time in the possession of Dr. Sandwith, was killed, and carefully preserved in spirit, previous to being remitted to England. The chief portion of Professor Owen's paper was occupied with a description of the details of the osteology of the animal. Its description will form the subject of future papers.

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## LINNÆAN SOCIETY.—*January* 16.

Discovery of the Welwitschia Mirabilis.—The first meeting of the current year (held at Burlington House) was most auspiciously inaugurated by a lengthened verbal communication from Dr. J. D. Hooker, F.R.S., who described to the meeting "the most remarkable plant that ever came to this country." Space will not allow us to follow Dr. Hooker with minute details, but we may remark that the new plant, for which the name of *Welwitschia mirabilis* is proposed, is not only structurally the most peculiar, but it is probably the ugliest plant that has ever been seen. It was discovered by Dr. Welwitsch, A.L.S., beyond the northern limits of Cape Town, Southern Africa, and from the letters of that indefatigable botanist, as well as from the specimens exhibited by Dr. Hooker, we learn that the *Welwitschia* is a stunted-looking kind of tree, whose summit never reaches more than two feet above the level of the ground, whilst the short woody trunk never possesses more than two leaves. These extraordinary leaves are, in point of fact, the expanded seed-lobes, or cotyledons, which make their appearance as soon as the young plant rises out of the ground; and, what is still more astonishing, these aforesaid leaves live, grow, and remain attached to the stumpy trunk during the entire life of the tree, which, it is calculated, lives at least one hundred years. We may also further observe that these two persistent foliar organs spread out laterally; in some fine examples of the *Welwitschia* attaining, each of them, a length of nearly six feet. The flowering axes shoot up from the summit of the stumpy trunk, which is flattened at the top, and like a folded card-table is divided by a



XUM

central line into two equal halves. The root is conical, and longer than that part of the trunk which appears above ground. There are many other points of peculiar scientific interest connected with the form and structure of this astonishing plant. These details, with ample illustrations, will duly appear in the next part of the Linnæan Society's "Transactions," for the issue of which, towards the close of the year, all botanists will consequently look forward with unusual anxiety.

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## NOTES AND MEMORANDA.

NEW POLARISCOPE OBJECT.—Mr. Davies, writing in the "Quarterly Journal of Microscopic Science," describes a double sulphate of copper and magnesia, obtained by mixing solutions of the two sulphates, and then crystallizing, as exhibiting beautiful polarizing powers. He says it is rather difficult to crystallize well. It ought to exhibit "peculiar flower-like forms."

THE MANGOLD-WURZEL FLY.—The Rev. W. Haughton describes, in the "Quarterly Journal of Microscopic Science," that fly whose larva has recently proved destructive to mangold-wurzel. Until last year it seems that the male sex predominated, and consequently little harm was done; then, however, the proportions were reversed, the females being estimated as twelve to one, and hence the extent of their injurious work.

CIRCULATION IN THE TADPOLE.—The "Quarterly Journal of Microscopic Science," for January 1862, contains an interesting paper by Mr. Whitney, on the circulation of the tadpole, explaining the means by which this creature enjoys "a much higher circulation of the blood than the reptile arrangement will permit." By selecting very transparent specimens, and keeping others upon water diet, so as to prevent the intestines containing opaque matter, he was able to trace the connection between the three great arterial trunks (the cephalic, pulmonary, and aortic) with the lungs. In the course of his experiments he endeavoured to remove all opaque matter from the convoluted bowel by purgative drugs; but the nauseous preparations did no exhibit any cathartic effect.

DISPERSION OF LIGHT.—M. Radau, writing in "Cosmos," upon the researches of Cauchy, and citing his formulæ, observes, "it results from these formulæ that the velocity of a luminous ray depends, in general, upon its colour; and that the unequal velocities of the different rays of the spectrum is the cause of their dispersion by the prism."

GIGANTIC CEPHALOPOD.—M. Flourens has recently communicated to the French Academy an account of an enormous cephalopod, seen by Lieut. Bouyer, about forty leagues north of Teneriffe. It appeared to be about ten to fifteen mètres in length (from thirty-one to forty-six feet), having a soft gelatinous body of a reddish colour and shaped like an immense horn; the widest part being about two yards in diameter; and surrounded by very strong arms or tentacles. It was repeatedly shot at, and the balls passed through it without doing much harm. On one occasion, however, a quantity of blood and froth, of a musky odour, flowed from the wound. After being harpooned several times, the body of the creature was surrounded by a rope, and efforts were made to haul it on board. Unfortunately the rope cut the soft flesh, and only the posterior part was secured. The sailors wished to pursue the remainder of the monster in a boat, but Lieut. Bouyer was afraid that its long tentacles, armed with suckers, might enable it to swamp them, and it was therefore permitted to escape. M. Moquin Tandon added some further particulars, and exhibited a sketch. He observed that the fishermen of the Canaries often met with similar creatures, exceeding one or even

two yards in length; but they were afraid to attack them. M. Milne Edwards recited numerous instances of the appearance of monster Cephalopods.—Rang had seen one with a body as big as a hogshead; and Steenstrup examined the body of another, which was thrown on the shores of Jutland; and which he denominated *Architeuthis dux*. M. Milne Edwards considered there was reason to believe that these large Cephalopods were not all of the same species; and he had no doubt that many kinds, which existed in the depths of the sea, far exceeded the bulk of any known invertebrate animal.

ARTIFICIAL CRYSTALS.—M. Becquerel has succeeded in producing opals and other crystalline minerals, in a short space of time, by strong currents of electricity. In order to succeed in these experiments, the solution must be pure, and of a particular strength, while the intensity of the current must be regulated by the nature of the materials. From a solution of sulphate of alumina he obtained, in the course of a few hours, a hydrate of alumina, like diopside, hard enough to scratch quartz. In like manner he has hopes of ultimately producing topazes and sapphires.

WHY OYSTERS ARE NOT FOUND IN THE BALTIC.—The St. Petersburg naturalists tell us that while oysters are found in the Mediterranean, the Atlantic, the North Sea, and the northern parts of the Cattegat, they do not occur in the Baltic, and refuse to be naturalized there. These facts are accounted for by the small percentage of salt which the Baltic waters contain. The waters of the Mediterranean contain 3·7 per cent. of salt; those of the Atlantic, 3 to 3·6 per cent.; the north of the Cattegat, 1·8 to 2 per cent.; while the saltest part of the Baltic yields only 1·7 per cent. of salt.

ONE-CHIMNEY HOUSES.—We find an account, in "Cosmos," of a plan of making all the fires of a house communicate with one chimney. The stoves employed are of a smoke-consuming kind, and the "unitary chimney" descends to the cellar, where it is closed with a plug, which can be removed when sweeping is required.

THE UNIVERSAL ACHROMATIC MICROSCOPE.—This is the name given by Messrs. Smith, Beck, and Beck to a very valuable instrument upon a new plan, and intermediate in quality between the ordinary educational microscopes, and those of the first class. The form is peculiar, and evidently devised with greater regard to facility of manufacture, than elegance of effect. It is not, however, bad looking, and presents a combination of advantages not previously offered at so low a price. A heavy ring of metal supplies a solid foot, and on one side rises a short pillar, by which the body of the instrument is supported, and upon which it is balanced, so that it can be inclined and fixed at any angle. The body is square, but this does not affect the shape of the field, which is round as in ordinary patterns. The eye-pieces are on Kelner's principle, having the field lens in the focus of the eye lens, an arrangement which has the inconvenience of making any particle of dust on the former exceedingly troublesome, but which possesses the advantage of giving a large flat field, and of obtaining a given power from the objectives with a shorter body than the usual Huyghenian eye-pieces require. The objectives are two in number, of one inch and one quarter inch focal lengths. A large and conveniently placed milled head moves the coarse adjustment, while a lever, like those in Mr. Ladd's instruments, makes a fine adjustment, delicate enough for all ordinary purposes. The mirror beneath the stage may be readily placed so as to supply oblique light, and a condenser upon a jointed stem suffices for opaque objects that do not require to be strongly lit. The stage is furnished with a somewhat clumsy-looking but effective apparatus for holding slides, and assisting their adjustment by hand, and is so made as to receive Wenham's parabola, the polariscope, or other additions which the purchaser may require. In its simplest state this microscope will suffice for the generality of observations, and its capacities may be brought up to a high standard by a small additional outlay. We were particularly struck with the quality of the objectives: the quarter inch, with the second eye-piece, enabled us immediately to exhibit both sets of lines on the *Pleurosigma formosum*, and we have no doubt it would resolve much more difficult tests.

XUM

Derivative Character of Chinese Literature.—M. de Paravey, after carrying on many investigation into the accounts of the *Quadrumana*, given in Chinese works, finds his opinion confirmed, that the ancient books now extant, belonging to this singular people, were founded upon others, still older, and written in countries remote from China.

Movements of the Heart.—MM. Chauveau and Marey have applied a self-registering instrument to record the movements of the human heart, and they inform us that the systole of the auricle begins and ends before that of the ventricle, and that the systole of the ventricle and the beating of the heart begin and terminate simultaneously, From these observations they conclude that the beating of the heart is not the result of the auricular systole, but of the systole of the ventricle. They publish in the *Comptes Rendus* (January 6, 1862), a diagram of the lines of their registering instruments, corresponding with the movements in the heart.

Recent Eruption of Vesuvius.—The Abbé Giardono, professor of physics in the University of Naples, contributes to "Cosmos" some interesting particulars concerning the last eruption of Vesuvius. He states that the mountain has been in nearly constant activity since 1855, when a great flood of lava overwhelmed half the valley of Vetrana and the ravines to the west of the crater. In 1858 there was another outbreak which lasted two years, and devastated a fertile tract of country. During this long period the grand crater at the summit of the cone never ceased to vomit forth fire. Then followed three months' tranquillity, broken at mid-day on the 8th December, by a violent shaking of the earth, which was felt as far as Naples. The first shock was followed by eight others, at intervals of ten or fifteen minutes, some of a vibratory and others of an undulating character. Then came half an hour's rest, and at three o'clock, without any trembling of the earth or other warning, a dense *cumulus* cloud of smoke rushed from the flanks of the mountain, and towered above the cone, forming the *pine-tree* appearance so famous in old observations, and rolling down in huge masses, driven towards the sea by the N.E. wind. At Torre del Greco the darkness was excessive, and volcanic ashes, not in an impalpable powder, but in a granular form, were scattered over the surrounding country. This immense quantity of matter was emitted from a chasm opened in the side of the volcano. At this spot the first new crater was formed, and afterwards a second and a third in the same line. They were about fifteen hundred yards from the craters of 1794, and opened in the midst of cultivated ground, the first actually commencing under the house of a husbandman named Abbrucei, who was fortunate enough to escape with his family. About an hour after the first crater was opened, the flow of lava began, accompanied by showers of scoriæ and volcanic bombs. Dismal bellowing noises were heard throughout the country, but nothing like the tremendous explosions that occurred in 1850. At first the fiery torrent directed its course S.E. towards Torre del Greco, and as it descended it acquired a breadth of more than three hundred yards. It was not liquid, but like a stiff paste, full of large masses of scoriæ of curious forms. It moved slowly through the night, sometimes stopping, sometimes advancing, and at five o'clock in the morning of the next day had not progressed more than a sixth of a league. The lava was rich in augite, and of a black colour. Up to this time the grand crater had taken no part in the eruption, but it began to pour forth smoke, cinders, and lava masses, which fell at the base of the cone. The lesser craters diminished their energies, and the lava torrent stopped as if by magic. This, which seemed to be the time of safety, was the moment for the destruction of the buildings in Torre del Greco, as the earth shook violently and opened in numerous *crevasses*, splitting the buildings right and left. The eruption was also signalized by electric discharges from the great cone; claps of thunder pealed every five or ten minutes from the interior of the crater; and flashes of lightning, straight and forked, illuminated the clouds.